DANA SPICER®
Off-Highway Products

Service Manual

Transmission
TE15 8-speed Long Drop

TSM-0227
May 2006

TOWING OR PUSHING

Before towing the vehicle, be sure to lift the driven axle wheels off the ground or disconnect the driveline to avoid damage to the transmission during towing.

Note:

BECAUSE OF THE DESIGN OF THE HYDRAULIC SYSTEM, THE ENGINE CANNOT BE STARTED BY PUSHING OR TOWING.

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FOREWORD

This manual has been prepared to provide the customer and the maintenance personnel with information and instructions on the maintenance and repair of the SPICER OFF-HIGWAY PRODUCTS product.

Extreme care has been exercised in the design, selection of materials, and manufacturing of these units. The slight outlay in personal attention and cost required to provide regular and proper lubrication, inspection at stated intervals, and such adjustments as may be indicated, will be reimbursed many times in low cost operation and trouble-free service.

In order to become familiar with the various parts of the product, its principle of operation, troubleshooting and adjustments, it is urged that the mechanic studies the instructions in this manual carefully and uses it as a reference when performing maintenance and repair operations.

Whenever repair or replacement of component parts is required, only SPICER OFF-HIGHWAY PRODUCTS approved parts as listed in the applicable parts manual should be used. Use of “will-fit” or non-approved parts may endanger proper operation and performance of the equipment. SPICER OFF-HIGHWAY PRODUCTS does not warrant repair or replacement parts, nor failures resulting from the use of parts which are not supplied or approved by SPICER OFF-HIGHWAY PRODUCTS.

IMPORTANT
ALWAYS FURNISH THE DISTRIBUTOR WITH THE SERIAL AND MODEL NUMBER WHEN ORDERING PARTS.

1. SAFETY PRECAUTIONS

SAFETY PRECAUTIONS

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe reliable operation of the machine. If replacement parts are required, the parts must be replaced by spare parts which have the same part number or with equivalent parts. **DO NOT USE A SPARE PART OF LESSER QUALITY.**

The service procedures recommended in this manual are effective methods for performing service and repair. Some of these procedures require the use of tools specifically designed for the purpose.

Accordingly, anyone who intends to use a spare part, service procedure or tool, which is not recommended by **SPICER OFF-HIGHWAY PRODUCTS**, must first determine that neither his safety nor the safe operation of the machine will be jeopardised by the spare part, service procedure or tool selected.

IMPORTANT
IT IS IMPORTANT TO NOTE THAT THIS MANUAL CONTAINS VARIOUS 'CAUTIONS AND NOTICES' THAT MUST BE CAREFULLY OBSERVED IN ORDER TO REDUCE THE RISK OF PERSONAL INJURY DURING SERVICE OR REPAIR, OR THE POSSIBILITY THAT IMPROPER SERVICE OR REPAIR MAY DAMAGE THE UNIT OR RENDER IT UNSAFE.
IT IS ALSO IMPORTANT TO UNDERSTAND THAT THESE ' CAUTIONS AND NOTICES' ARE NOT EXHAUSTIVE, BECAUSE IT IS IMPOSSIBLE TO WARN ABOUT ALL POSSIBLE HAZARDOUS CONSEQUENCES THAT MIGHT RESULT FROM FAILURE TO FOLLOW THESE INSTRUCTIONS.

CAUTION

WHEN MAINTENANCE WORKS REQUIRE WELDING, DISCONNECT BOTH CONNECTORS FROM THE APC200 AND FROM THE VALVE UNIT, BEFORE ANY WELDING IS STARTED.

2.1 CLEANING

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

CAUTION

CARE SHOULD BE EXERCISED TO AVOID SKIN RASHES, FIRE HAZARDS, AND INHALATION OF VAPOURS WHEN USING SOLVENT TYPE CLEANERS.

2.1.1 BEARINGS

Remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. DO NOT SPIN BEARINGS WHEN DRYING. Bearings may be rotated slowly by hand to facilitate drying process.

2.1.2 HOUSINGS

Clean interior and exterior of housings, bearing caps, etc... thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces.
Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.

CAUTION

CARE SHOULD BE EXERCISED TO AVOID INHALATION OF VAPOURS AND SKIN RASHES WHEN USING ALKALI CLEANERS.

All parts cleaned must be thoroughly dried immediately by using moistere-free compressed air or soft lintless absorbant wiping rags, free of abrasive materials such as metal fillings, contaminated oil or lapping

2.2 INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

2.2.1 BEARINGS

Carefully inspect all rollers: cages and cups for wear, chipping, or nicks to determine fitness of bearings for further use. DO NOT REPLACE A BEARING CONE OR CUP INDIVIDUALLY without replacing the mating cup or cone at the same time. After inspection, dip bearings in Automatic Transmission Fluid and wrap in clean lintless cloth or paper to protect them until installed.

2.2.2 OIL SEALS, GASKETS, ETC.

Replacement of spring load oils seals, “O” rings, metal sealing rings, gaskets and snap rings is more economical when the unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching or curling under of lips of seals seriously impairs its efficiency.
When assembling new metal type sealing rings, these should be lubricated with a coat of chassis grease to stabilise rings in their grooves for ease of assembly of mating members. Lubricate all “O” rings and seals with recommended type Automatic Transmission Fluid before assembly.

2.2.3 GEARS & SHAFTS

If Magna-Flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent or spline-twisted, and that shafts are true.

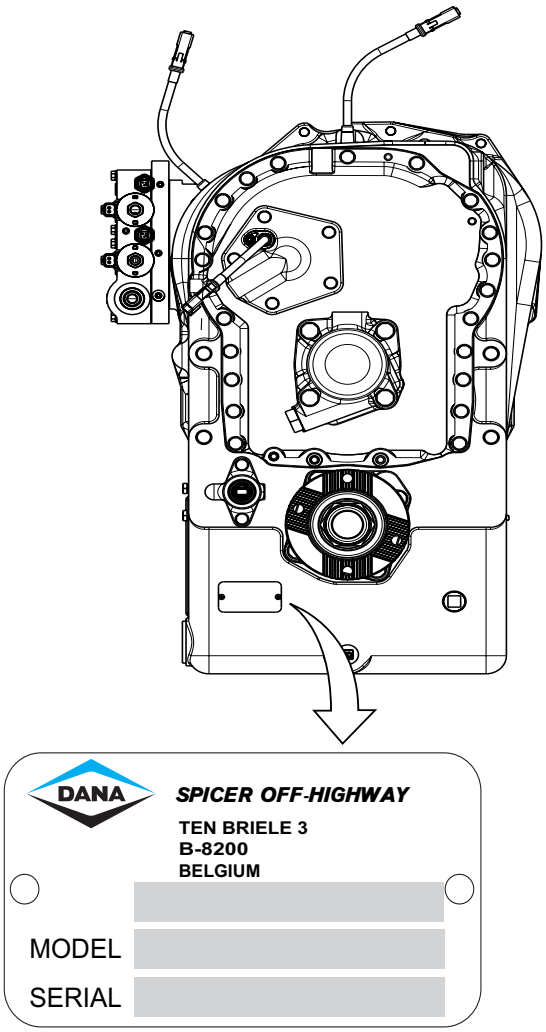
2.2.4 HOUSINGS, COVERS, ETC.

Inspect housings, covers and bearing caps to ensure that they are thoroughly clean and that mating surfaces, bearing bores, etc... are free from nicks or burrs. Check all parts carefully for evidence of cracks or conditions which would cause subsequent oil leaks or failures.

2.3 LEGEND SYMBOLS

	Smontaggio di sottogruppi Disassembly of assembly groups
	Montaggio di sottogruppi Reassemble to from assembly group
	Smontaggio di particollari ingombranti Remove obstruction parts
	Montaggio di particollari ingombranti Reinstall - remount parts which had obstructed disassembly
	Attenzione, indicazione importante Attention! important notice
	Controllare regolare p.e. coppie, misure, pressione etc. Check - adjust e.g. torque, dimensions, pressures etc.
	T = Attrezzature speciali P = Pagina T = Special tool P = Page
	Rispettare direzione di montaggio Note direction of installation
	Controllare esaminare controllo visuale Visual inspection
	Eventualimente riutilizzable (sostituire se necessario) Possibly still serviceable, renew if necessary

	Sostituire con ogni montaggio Renew at each reassembly
	Togliere - mettere la sicura Unlock - lock e.g. split pin, locking plate, etc.
	Mettere la sicura, incollare (mastice liquido) Lock - adhere (liquid sealant)
	Evitare danni ai materiali, danni ai pezzi Guard against material damage, damage to parts
	Marchiari prima dello smontaggio (per il montaggio) Mark before disassembly, observe marks when reasembl.
	Carricare riempire (olio - lubrificante) Filling - topping up - refilling e.g. oil, cooling water, etc.
	Scarricare olio, lubrificante Drain off oil, lubricant
	Tendere Tighten - clamp ; tightening a clamping device
	Insere pressione nel circuito idraulico Apply pressure into hydraulic circuit
	Pulire To clean



3.1. IDENTIFICATION OF THE UNIT

1. Model and type of the unit
2. Serial number.

3.2. WEIGHT, DIMENSIONS, OIL CAPACITY

Weight (dry):	381 Kg [840 lb]
Max. Length:	730 mm [28.74”]
Max. With:	554 mm [21.81”]
Max. Heigth:	775 mm [30.51”]

Oil capacity

18.9 liter [5 US Gallon] without cooler and hydraulic lines.
Consult Operator’s manual on applicable machine for system capacity.

3.3 TORQUE CHARTS

Torque specifications for lubricated or plated threads						
	GRADE 8.8		GRADE 10.9		GRADE 12.9	
	COARSE THREAD		COARSE THREAD		COARSE THREAD	
NOM. SIZE	LBF - FT	[N.m]	LBF - FT	[N.m]	LBF - FT	[N.m]
M5 x 0.8	3.7 - 4.4	[5 - 6]	5.2 - 5.9	[7 - 8]	5.9 - 7.4	[8 - 10]
M6 x 1	5.9 - 7.4	[8 - 10]	8.9 - 11.1	[12 - 15]	9.6 - 11.8	[13 - 16]
M8 x 1.25	14.8 - 18.4	[20 - 25]	22.1 - 25.8	[30 - 35]	25.8 - 29.5	[35 - 40]
M10 x 1.5	29.5 - 36.9	[40 - 50]	44.3 - 47.9	[60 - 65]	47.9 - 55.3	[65 - 75]
M12 x 1.75	50.2 - 55.3	[68 - 75]	73.8 - 81.1	[100 - 110]	85 - 96	[115 - 130]
M14 x 2	81 - 92	[110 - 125]	111 - 129	[150 - 175]	133 - 155	[180 - 210]
M16 x 2	125 - 140	[170 - 190]	177 - 203	[240 - 275]	207 - 236	[280 - 320]
M20 x 2.5	236 - 266	[320 - 360]	332 - 369	[450 - 500]	387 - 443	[525 - 600]
M24 x 3	420 - 479	[570 - 650]	590 - 664	[800 - 900]	664 - 774	[900 - 1050]
M30 x 3.5	848 - 959	[1150 - 1300]	1180 - 1328	[1600 - 1800]	1364 - 1549	[1850 - 2100]
M36 x 4	1475 - 1660	[2000 - 2250]	2028 - 2323	[2749 - 3149]	2397 - 2729	[3249 - 3699]

	GRADE 8.8		GRADE 10.9		GRADE 12.9	
	FINE THREAD		FINE THREAD		FINE THREAD	
NOM. SIZE	LBF - FT	[N.m]	LBF - FT	[N.m]	LBF - FT	[N.m]
M8 x 1	17 - 20	[23 - 28]	25 - 28	[34 - 39]	30 - 34	[41 - 46]
M10 x 1	35 - 42	[47 - 57]	52 - 60	[71 - 81]	62 - 69	[84 - 94]
M10 x 1.25	32 - 40	[44 - 54]	49 - 57	[67 - 77]	58 - 66	[79 - 89]
M12 x 1.25	60 - 68	[82 - 92]	89 - 96	[120 - 130]	105 - 116	[143 - 158]
M12 x 1.5	58 - 65	[78 - 88]	86 - 94	[117 - 127]	101 - 112	[138 - 153]
M14 x 1.5	94 - 105	[128 - 143]	142 - 153	[193 - 208]	162 - 184	[220 - 250]
M16 x 1.5	159 - 169	[215 - 228]	216 - 227	[293 - 308]	258 - 273	[350 - 370]
M18 x 1.5	221 - 236	[300 - 320]	319 - 330	[433 - 448]	369 - 398	[500 - 540]
M18 x 2	207 - 221	[280 - 300]	304 - 315	[413 - 428]	347 - 376	[470 - 510]
M20 x 1.5	302 - 332	[410 - 450]	439 - 476	[595 - 645]	503 - 559	[683 - 758]
M22 x 1.5	413 - 443	[560 - 600]	586 - 623	[795 - 845]	681 - 736	[923 - 998]
M24 x 1.5	531 - 590	[720 - 800]	767 - 841	[1040 - 1140]	882 - 992	[1195 - 1345]
M24 x 2	509 - 568	[690 - 770]	730 - 804	[990 - 1090]	845 - 955	[1145 - 1295]
M27 x 1.5	789 - 848	[1070 - 1150]	1129 - 1202	[1530 - 1630]	1309 - 1420	[1775 - 1925]

3.3 TORQUE CHARTS (CONTINUED)

Torque specifications for lubricated or plated threads				
	GRADE 5			
	FINE THREAD		COARSE THREAD	
NOM. SIZE	LBF - FT	[N.m]	LBF - FT	[N.m]
1/4	9 - 11	[12 - 15]	8 - 10	[11 - 14]
5/16	16 - 20	[22 - 27]	12 - 16	[16 - 22]
3/8	26 - 29	[35 - 39]	23 - 25	[31 - 34]
7/16	41 - 45	[56 - 61]	37 - 41	[50 - 56]
1/2	64 - 70	[87 - 95]	57 - 63	[77 - 85]
9/16	91 - 100	[123 - 136]	82 - 90	[111 - 122]
5/8	128 - 141	[173 - 191]	113 - 124	[153 - 168]
3/4	223 - 245	[302 - 332]	200 - 220	[271 - 298]

Torque specifications for lubricated or plated threads				
	GRADE 8			
	FINE THREAD		COARSE THREAD	
NOM. SIZE	LBF - FT	[N.m]	LBF - FT	[N.m]
1/4	11 - 13	[15 - 18]	9 - 11	[12 - 15]
5-16	28 - 32	[38 - 43]	26 - 30	[35 - 41]
3/8	37 - 41	[50 - 56]	33 - 36	[45 - 49]
7/16	58 - 64	[79 - 87]	52 - 57	[70 - 77]
1/2	90 - 99	[122 - 134]	80 - 88	[108 - 119]
9/16	128 - 141	[174 - 191]	115 - 127	[156 - 172]
5/8	180 - 198	[224 - 268]	159 - 175	[216 - 237]
3/4	315 - 347	[427 - 470]	282 - 310	[382 - 420]

Torque specifications for plugs		
NPFT	O-ring ports	
NOM. SIZE	LBF - FT	[N.m]
5/16 x 24	3 - 5	[4 - 7]
3/8 x 24	5 - 8	[7 - 11]
7/16 x 20	7 - 10	[9 - 14]
1/2 x 20	10 - 13	[14 - 18]
9/16 x 18	12 - 15	[16 - 20]
3/4 x 16	20 - 25	[27 - 34]
7/8 x 14	30 - 35	[41 - 47]
1 1/16 x 12	45 - 50	[61 - 68]
1 5/16 x 12	65 - 75	[88 - 102]
1 5/8 x 12	75 - 85	[102 - 115]
1 7/8 x 12	75 - 85	[102 - 115]

Torque specifications for plugs		
METRIC	Permanent plugs	
NOM. SIZE	LBF - FT	[N.m]
M18 x 1.5 6H	34 - 41	[25 - 30]
M26 x 1.5 6H	61 - 68	[45 - 50]

Torque specifications for plugs		
METRIC	O-ring plugs	
NOM. SIZE	LBF - FT	[N.m]
M10 x 1	6 - 7	[8 - 9]
M12 x 1.5	9 - 13	[14 - 18]
M14 x 1.5	12 - 15	[16 - 20]
M16 x 1.5	20 - 25	[27 - 34]
M18 x 1.5	25 - 30	[34 - 41]
M22 x 1.5	35 - 44	[48 - 60]
M26 x 1.5	45 - 50	[61 - 68]
M27 x 2	60 - 66	[81 - 89]
M33 x 2	83 - 103	[112 - 140]

Torque specifications		
NFPT	Elastic Stop Nuts	
NOM. SIZE	LBF - FT	[N.m]
1.00 x 20	150 - 200	[542 - 610]
1.25 x 18	200 - 250	[407 - 474]
1.50 x 18	300 - 350	[271 - 339]
1.75 x 12	400 - 450	[203 - 271]

Torque specifications for plugs		
	Pipe plugs	
NOM. SIZE	LBF - FT	[N.m]
1/16 x 27	5 - 7	[7 - 9]
1/8 x 27	7 - 10	[9 - 14]
1/4 x 18	15 - 20	[20 - 27]
3/8 x 18	25 - 30	[34 - 41]
1/2 x 14	30 - 35	[41 - 47]
3/4 x 14 or 10	40 - 45	[54 - 61]
1 x 11 1/2	50 - 55	[68 - 75]
1 1/4 x 11 1/2	60 - 65	[81 - 88]

3.4 PRESSURE & TEMPERATURE SPECIFICATIONS

- Normal operating temperature 70 - 120°C [158 - 248F] measured at temperature check port to cooler (port 71 - **).

- Maximum allowed transmission temperature 120°C [248 F].

- Transmission regulator pressure (*) - (neutral) - port 31 (**).
  - 16.55 bar [240 PSI] or 19.31 [280 PSI] depending on converter type.

- Pump flow (*)
  - at 2000 RPM in neutral: 91 l/min. minimum [20.0 GPM] or 106 l/min [28 GPM] depending on converter and pump type.

- Clutch pressures (*)
  - 1st clutch: port 41 (**).
  - 2nd clutch: port 42 (**).
  - 3rd clutch: port 43 (**).
  - 4th clutch: port 44 (**).
  - forward clutch: port 45 (**).
  - reverse clutch: port 46 (**).

  Clutch pressure is 16.55 bar [240 PSI] or 19.31 bar [280 PSI] depending on converter type when clutch is activated.

- Safety valve : cracking pressure (*) 8.96 bar - 12.07 bar [130 PSI - 175 PSI].

- To cooler (converter out) pressure (*) (port 32) 1.72 bar min. (25 PSI) at 2000 RPM and max. 4.83 bar (70 PSI) at no load governed speed).

(*)All pressures and flows to be measured with oil temperature of 82 - 93° C (180 - 200F).
(**) Refer to section troubleshooting for check port identification.

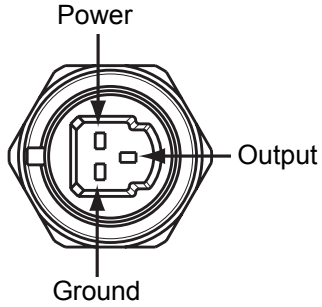
3.5 ELECTRICAL SPECIFICATIONS

- Proporsional valves (Fwd,Rev,1st-3rd,2nd-4th).
  coil resistance : 7.25 Ω at 20°C [68°F].
  Operation temperature between -40° C [-40°F] and 120° C [248°F]
  The valves are equiped with a DEUTSCH D T04 2P connector.

- Total neutral and 1st-3rd/ 2nd-4th range solenoid:
  coil resistance : 12V 7,1 Ω at 20°C [68°F].
  24V 28.5 Ω at 20°C [68°F].

- Speed sensor :
  - type: magneto resistive sensor.
  - Sensor signal: generates a square current with a fixed amplitude changing between 7 and 14 mA.

- Pressure sensor :
  Sensors must be supplied with 5Vdc and put out between 5% & 95% of the supplied current related to 1 bar (0.25V) and 31 bar (4.75V) pressure.
  Remark: max 10mA supply current.
  Sensor is equiped with a 3 pin connector.

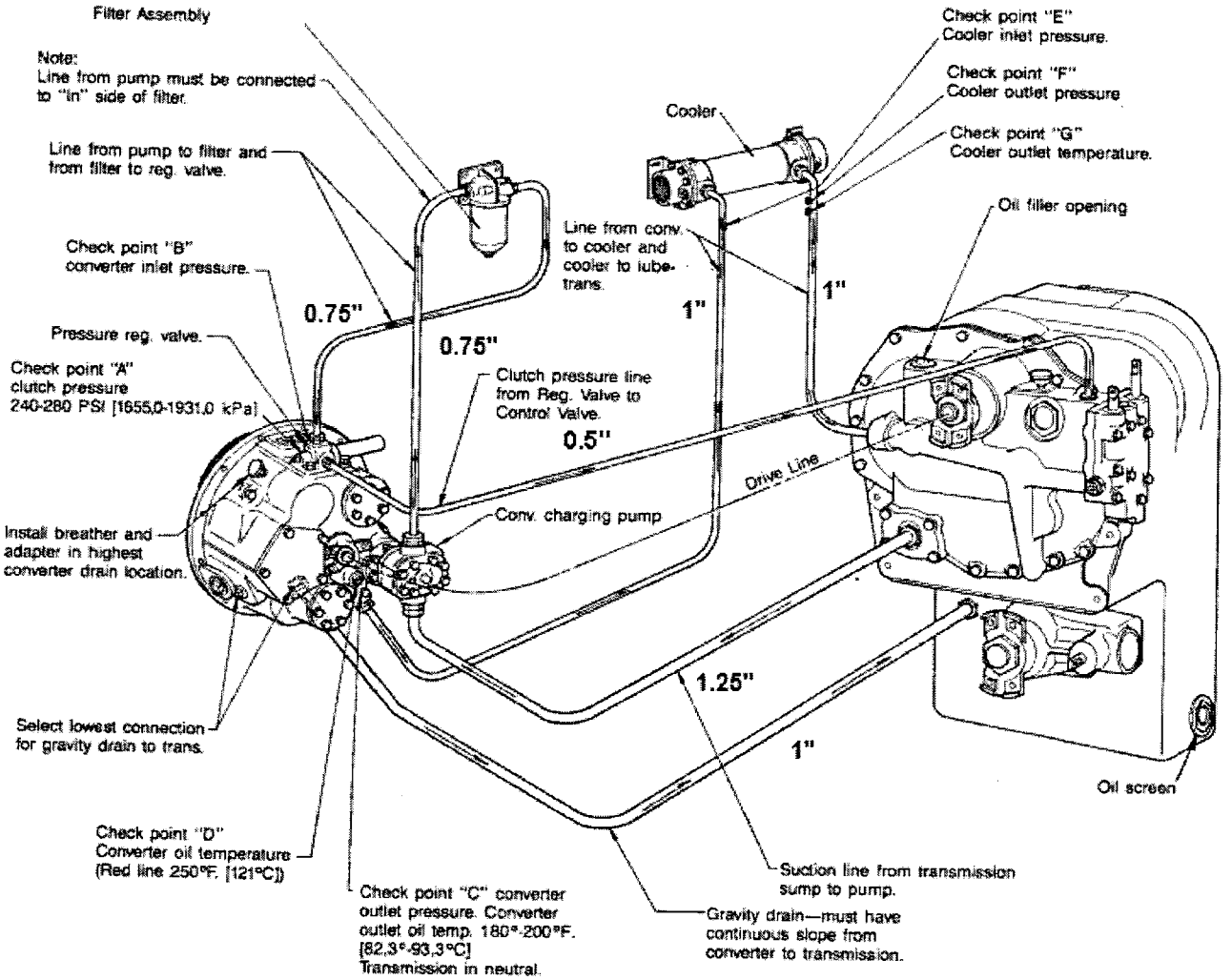


- Temperature sensor (in speed sensor) resistance versus temp. :see table

T_{amb} ° C	Resistance Ω
-50	1036
-40	1140
-30	1250
-20	1370
-10	1496
0	1630
10	1772
20	1922
25	2000
30	2080
40	2246
50	2418

T_{amb} ° C	Resistance Ω
60	2600
70	2785
80	2984
90	3188
100	3400
110	3620
120	3846
125	3972
130	4082
140	4256
150	4470

TE15 - C270/C320 EXTERNAL PLUMBING DIAGRAM


Filter Assembly
Note:
Line from pump must be connected to "in" side of filter.
Line from pump to filter and from filter to reg. valve.
Check point "B" converter inlet pressure.
Pressure reg. valve.
Check point "A" clutch pressure 240-280 PSI [1655,0-1931,0 kPa]
Install breather and adapter in highest converter drain location.
Select lowest connection for gravity drain to trans.
Check point "D" Converter oil temperature (Red line 250°F. [121°C])
Check point "C" converter outlet pressure. Converter outlet oil temp. 180°-200°F. [82,3°-93,3°C] Transmission in neutral.
Operating specifications: 25 PSI [172,0 kPa] minimum pressure at 2000 RPM engine speed and a maximum of 70 PSI [483,0 kPa] outlet pressure with engine operating at no-load governed speed.
Gravity drain—must have continuous slope from converter to transmission.
Suction line from transmission sump to pump.
Oil screen
Check point "E" Cooler inlet pressure.
Check point "F" Cooler outlet pressure
Check point "G" Cooler outlet temperature.
Cooler
Oil filler opening
Line from conv. to cooler and cooler to lube-trans.
Clutch pressure line from Reg. Valve to Control Valve.
Conv. charging pump
Drive Line
0.75"
0.75"
0.5"
1"
1"
1.25"
1"

Metric dimensions shown in brackets [ ].

Note: Do not deviate any line size.

Notes:
Hose line operating requirements.

1. **Pressure Lines**—Suitable for operation from ambient to 250°F. [121,1°C] continuous operating temperature. Must withstand 300 PSI [2068 kPa] continuous pressure with 500 PSI [4137 kPa] intermittent surges. Ref. S.A.E. Spec. No. J517,100R1 Hydraulic Hose Specification.
2. **Suction Line**—to be protected from collapse by interwoven steel wire. Ref. S.A.E. Spec. No. J517,100R4 Hydraulic Hose Specification. Suitable for operation from ambient to 250°F. [121,1°C]. Continuous operating temperature.
3. **Gravity Drain Line**—Suitable for operation from ambient to 250°F. [121,1°C] continuous operating temperature. Ref. S.A.E. Spec. No. J517,100R1 Hydraulic Hose Specification.
4. **All Hose Lines** used must conform to S.A.E Spec. No. J1019 Test Procedure for High Temp. Transmission Oil Hose.
5. See Lubrication Specifications.

4.1. OIL SPECIFICATION

4.1.1 RECOMMENDED LUBRICANTS

- Only Dexron* III, viscosity at 40° C [104° F]: 33 - 38 cSt
  100° C [212° F]: 7 - 8 cSt

SUMP PREHEATERS

Preheat the transmission fluid to the mimimum temperature for the oil viscosity used before engine startup.

NORMAL OIL CHANGE INTERVAL

Drain and refill system every 1000 hrs for average environmental and duty cycle conditions. Severe or sustained high operating temperature or very dusty atmospheric conditions will result in accelerated detioration or contamination. Judgement must be used to determine the required change intervals for extreme conditions.

Drain and refill system as follows (drain with oil at 65 - 93° C [150 - 200 F°])

1. Drain transmission.
2. Remove and discard filter. Install new filter.
3. Refill transmission to FULL mark.
4. Run engine at 500 - 600 RPM to prime convertor and lines.
5. Recheck level with engine running at 500 - 600 RPM and add oil to bring level to LOW mark. When oil temperature is hot 82.2 - 93.3 °C (180- 200 F) make final oil level check and adjust if necessary to bring oil level to FULL mark.

Note

IT IS RECOMMENDED THAT OIL FILTER BE CHANGED AFTER 100 HOURS OF OPERATION ON NEW, REBUILT OR REPAIRED UNIT.

EXTENDED OIL CHANGE INTERVAL

Extended oil service life may result when using synthetic fluids. Appropriate change intervals should be determined for each transmission by measuring oil oxidation and wear metals over time, to determine a baseline. Wear metals analysis can provide useful inforamtion but a transmission should not be removed from service based solely on this analysis.

FILTERS

Service oil filter element intervals
100hrs first time
Then every 500 hrs under normal envirronmental and duty cycle conditions.

4.2 MAINTENANCE INTERVALS

4.2.1 DAILY

Check oil level daily with engine running at idle (600 RPM) and oil at 82 - 93 °C (180-200 F).

Maintain oil level at full mark.

* DEXRON is a registered trademark of GENERAL MOTORS CORPORATION

4.2.2 CLUTCH CALIBRATION

EVERY 2000HRS PERFORM AUTOMATIC CLUTCH CALIBRATION

4.3 SERVICING MACHINE AFTER COMPONENTS OVERHAUL

The transmission, torque converter, and its allied hydraulic system are important links in the driveline between the engine and the wheels. The proper operation of either unit depends greatly on the condition and operation of the other. Therefore, whenever repair or overhaul of one unit is performed, the balance of the system must be considered before the job can be considered complete.
After the overhauled or repaired transmission has been installed in the machine, the oil cooler, and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several manners and a degree of judgement must be exercised as to the method employed.

The following are considered the minimum steps to be taken:

1. Drain entire system thoroughly.
2. Disconnect and clean all hydraulic lines. Where feasible hydraulic lines should be removed from machine for cleaning.
3. Replace oil filter element.
4. The oil cooler must be thoroughly cleaned. The cooler should be “back flushed” with oil and compressed air until all foreign material has been removed. Flushing in direction of normal oil flow will not adequately clean the cooler. If necessary, cooler assembly should be removed from machine for cleaning, using oil, compressed air, and steam cleaner for that purpose. DO NOT use flushing compounds for cleaning purposes.

IMPORTANT
DO NOT USE FLUSHING COMPOUNDS FOR CLEANING PURPOSES.

5. Reassemble all components and use only type oil recommended for lubrication section. Fill transmission through filler opening until fluid comes up to the oil level check port.

   Run engine 2 minutes at 500+600 R.P.M. to prime torque converter and hydraulic lines. Recheck level of fluid in transmission with engine running at idle (500-600 R.P.M.).

   Add quantity necessary to bring fluid level to oil level check port.

   Recheck with hot oil (180-200 F) 82-93° C.

6. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

4.4 PROCEDURE FOR PERFORMING AUTOMATIC CALIBRATION

4.4.1 INTRODUCTION

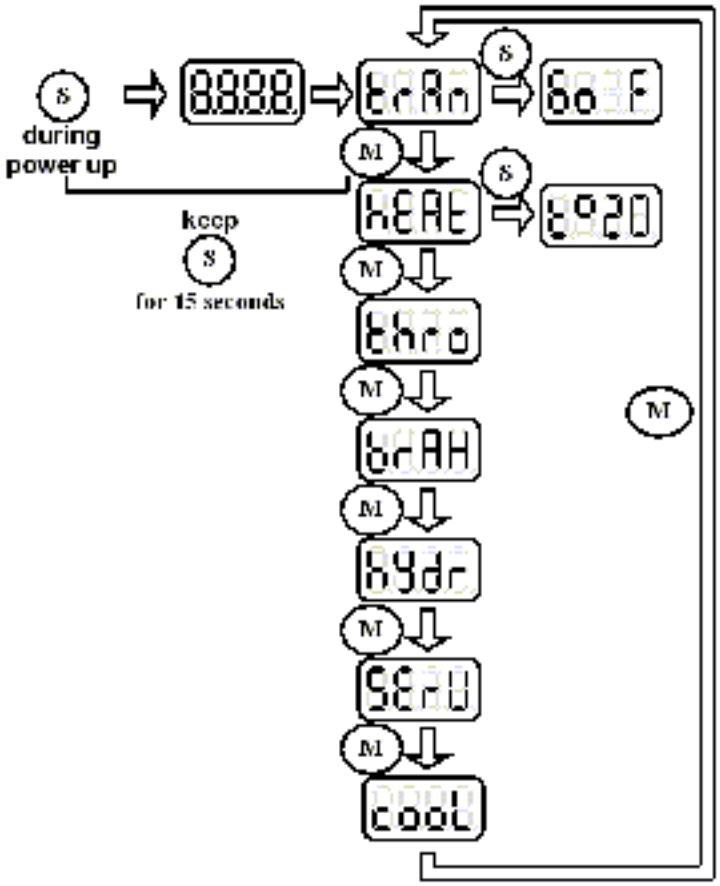
The APC200 firmware contains an automatic transmission calibration procedure, which is able to optimize the shift quality of the transmission.

An automatic calibration has to be done:

- When the vehicle is build at the OEM
- Every 2000 hrs of transmission operation
- When an overhaul of the transmission is done
- When the transmission is repaired
- When the APC200 is replaced

4.4.2 RUNNING THE AUTOMATIC CALIBRATION

4.4.2.1 HOW TO ENTER THE CALIBRATION MODE



The automatic calibration mode is entered by pressing the S-button on the APC200 <display for 15 seconds during POWER-UP of the APC200 (See above figure)

4.4.3 PERFORMING AN AUTOMATIC CALIBRATION

Before the automatic calibration can be started, a number of conditions need to be fulfi lled :

- The parking brake on the vehicle has to be activated.

- The transmission temperature needs to be above 60° C. See the next paragraph how to use the 'HEAT'-mode to do this in a time effective way.

- The engine speed has to be kept at around 800 rpm (± 200 rpm) during the complete calibration. If the APC200 has control over the engine, the engine speed will be adapted automatically.

If all the conditions mentioned above are met, the actual automatic calibration can be performed starting from the following display on the APC200 :

To trigger the automatic calibration procedure, push the S-button once. You will get this APC200-display readout:

The APC200 asks you to put the shift lever in FORWARD.
The automatic transmission calibration procedure starts. This is indicated on the APC200-display :

'c1' stands for 'clutch 1' being forward, while 'M1' stands for 'mode 1' of the calibration.

When all clutches have been calibrated, the APC200 displays :

At this point, the automatic calibration has completed successfully. The normal duration of a complete transmission calibration is around 15 minutes.

To exit the automatic calibration mode, you should need to switch off the ignition key the vehicle. Make sure that the APC200 has powered down – wait for 2 seconds. Now restart the vehicle and the new tuning results will be activated automatically.

REMARK 1 :

If you get any different information on the APC200 display as described above, there can be two possible reasons
:

- the calibration conditions are not fulfi lled (temperature is too low, parking brake switched off, the vehi cle is moving, engine rpm is too high or too low)

- a calibration error has occurred during the calibration (message starting with an 'E').

For possible messages see chapter 4.4.5

REMARK 2 :
By selecting REVERSE on the shift lever, while the automatic calibration is performing, the procedure will abort the automatic calibration immediately and restart the APC200. You can use this as an emergency procedure when something goes wrong during the calibration procedure.

Note : by aborting the automatic calibration, the calibration is not fi nalized and needs to be done from the beginning.

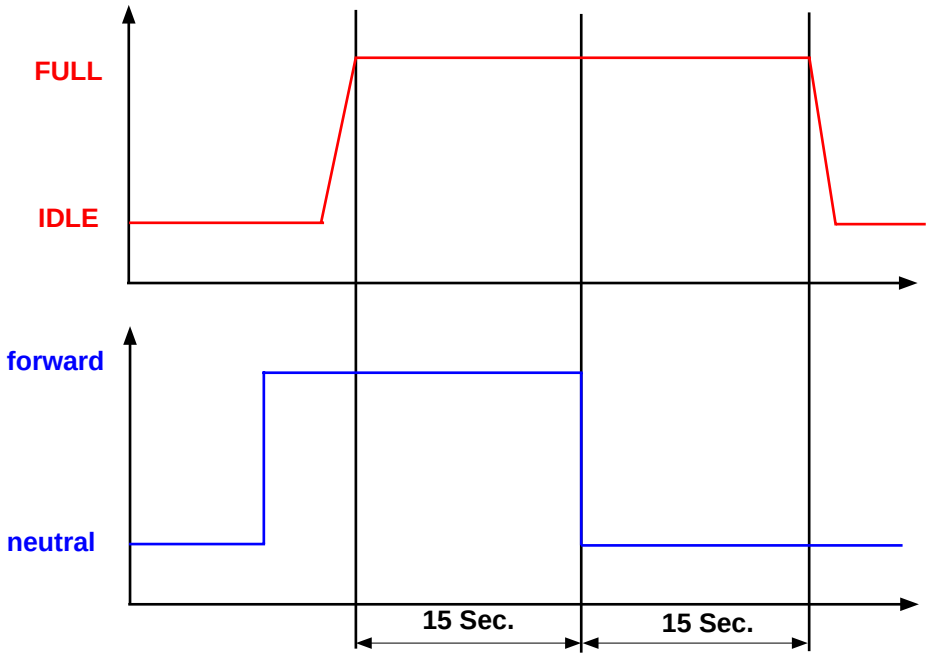
4.4.4 HEATING UP THE TRANSMISSION BY USING THE 'HEAT'-MODE

The 'HEAT'-mode allows to select forward / reverse while the parking brake is activated, without forcing neutral and will disable the inching and declutch function. During the heat mode the highest gear is forced – even when the shift lever is in a lower gear. This combination allows the driver to heat up the transmission by going into stall.

The paragraph how to enter the calibration mode (see 1st paragraph), also displays how the 'HEAT'-mode can be activated. Once you see on the display "tran", you can press the M-button once to go into the "heat"-mode. The APC200 will display :

To trigger the 'HEAT'-mode, push the S-button. The APC200 will display the sump temperature :

This means the actual sump temperature of the transmission is 20°C.



Perform the following steps in order to heat up the transmission :

1. Make sure the parking brake is active and works properly.

2. Put the transmission in forward by selecting forward with the shift lever and then accelerates the engine to full throttle.

3. Keep the engine at full throttle for about 15 seconds and then put the gearbox in neutral by selecting neutral with the shift lever. Keep the engine at full throttle!

4. Keep the gearbox in neutral at full engine throttle for about 15 seconds again.

5. Release the throttle pedal and decelerate the engine to idle.

6. Go back to point 2 and repeat until the APC200 display shows a temperature above 60°C. When the temperature is above 60° C, the temperature indication on the display starts blinking. Now you can switch to the automatic calibration, by pressing the M-button for several times – until the APC200 displays “tran”.

REMARK :

During this warm up procedure, it is possible that the converter out temperature of the transmission exceeds the maximum limit. This is a consequence of heating up the transmission using this quick procedure.

When this occurs, the engine speed will be limiting to half throttle when the APC200 has engine control or forcing neutral when the APC200 has no engine control. To solve this, simply leave the transmission in neutral for a minute and throttle the engine to around 1300 rpm. This will allow the heat in the converter to be evacuated.

After one or two minutes, you can resume the heating up procedure if the transmission temperature has not reached 60 °C yet.

4.4.5 CALIBRATION CONDITION MESSAGES AND CALIBRATION ERRORS

This chapter gives an overview of the most common calibration condition messages. Normally, you will be able to repair the cause of a calibration condition message yourself. However, you will have to contact the OEM of the machine when a calibration error appears.

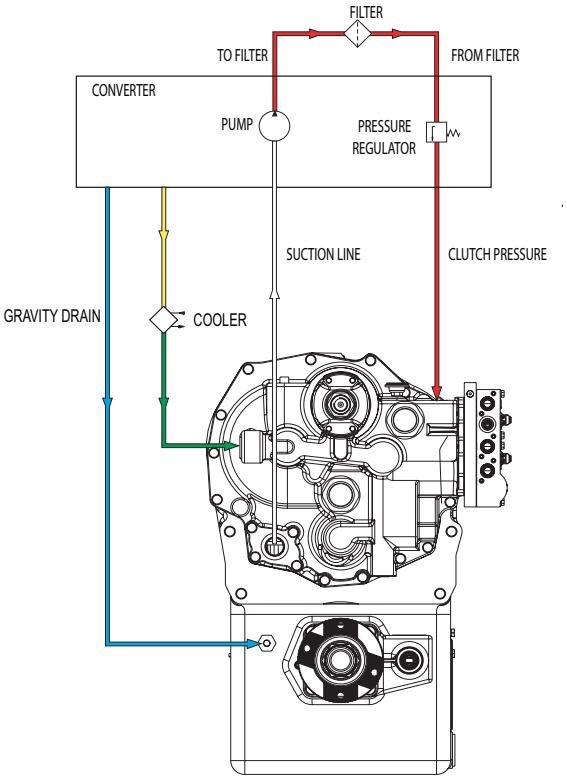
4.4.5.1 Calibration condition messages

	The APC200 expects the shift lever to be in NEUTRAL, but finds it in another position. (FORWARD or REVERSE)	Put the shift jever back in NEUTRAL
	THE APC200 expects the partking brake to be ON while it is OFF	Put the parking brake ON
	The APC200 has detected output speed	Verify that the parkiing brake is ON and working properly. If this is already the case, you will be obliged to keep the machine at standstill by using the footbrake. Once the machine has been stopped, the APC200 will ask the driver to shift to FORWARD before continuing the calibration.
	Engine RPM is to low according to the limit that is necessary for calibration.	If the vehicle is equiped with throttle-by-wire, the engine RPM will be automatically adapted. In the other case, the driver has to change the throttle pedal position until the display looks as follows:
	Engine RPM is to high according to the limit that is necessary for calibration.	
	After being to low or to high, the engine RPM is coming back into the correct bounderies for calibration	
	When during the automatic transmission calibration the temperature becomes to low, the APC200 display indicates the actual transmission temperature.	Use the M-button on the APC200 to go back to the 'HEAT' mode and the S-button to trigger this mode. Now you have to warm-up the transmission again until the temperature is above 60° C [140° F]. Then go back to the automatic tuning mode by the M-button and trigger this one again to continue calibration.

4.4.5.2 Calibration errors

Calibration errors have the form ‘E1.xx’ or ‘E2.xx’ (example : E1.25). Please contact the OEM of the machine if an error of this form appears on the display.

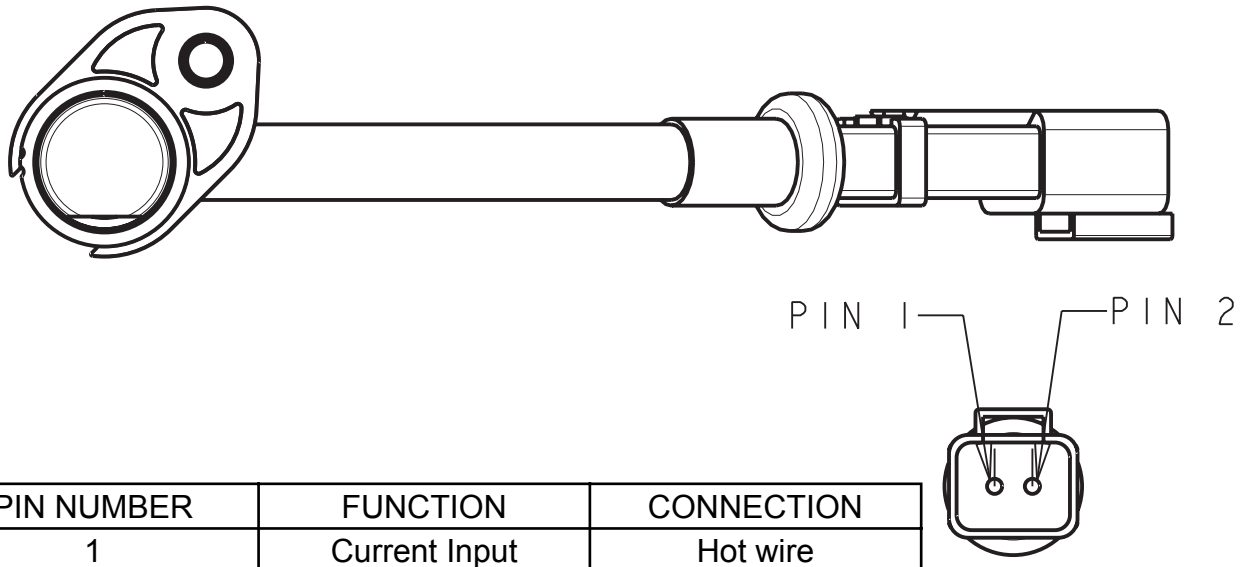
5.1 EXTERNAL PLUMBING



5.1.1 COOLER & FILTER LINES SPECIFICATIONS

- Minimum 19 mm (.75 inch) internal diameter for lines and fittings 25.4 [1"] for 28 GPM pump.
- Suitable for operation from ambient to 120 °C (248 F) continuous operating temperature.
- Must withstand 30 bar (435 psi) continuous pressure and with 45 bar (652 psi) intermittent surges.
- Conform SAE J1019 and SAE J517,100RI.

5.2 SPEED SENSOR



PIN NUMBER	FUNCTION	CONNECTION
1	Current Input	Hot wire
2	Current Output	Ground wire

the magneto resistive sensor generates a square wave current with a fixed amplitude changing between 7 mA and 14 mA.
The sensor has an integrated Deutz 2 pin connector DT04-2P
The two pins are numbered 1 & 2.

NOTE

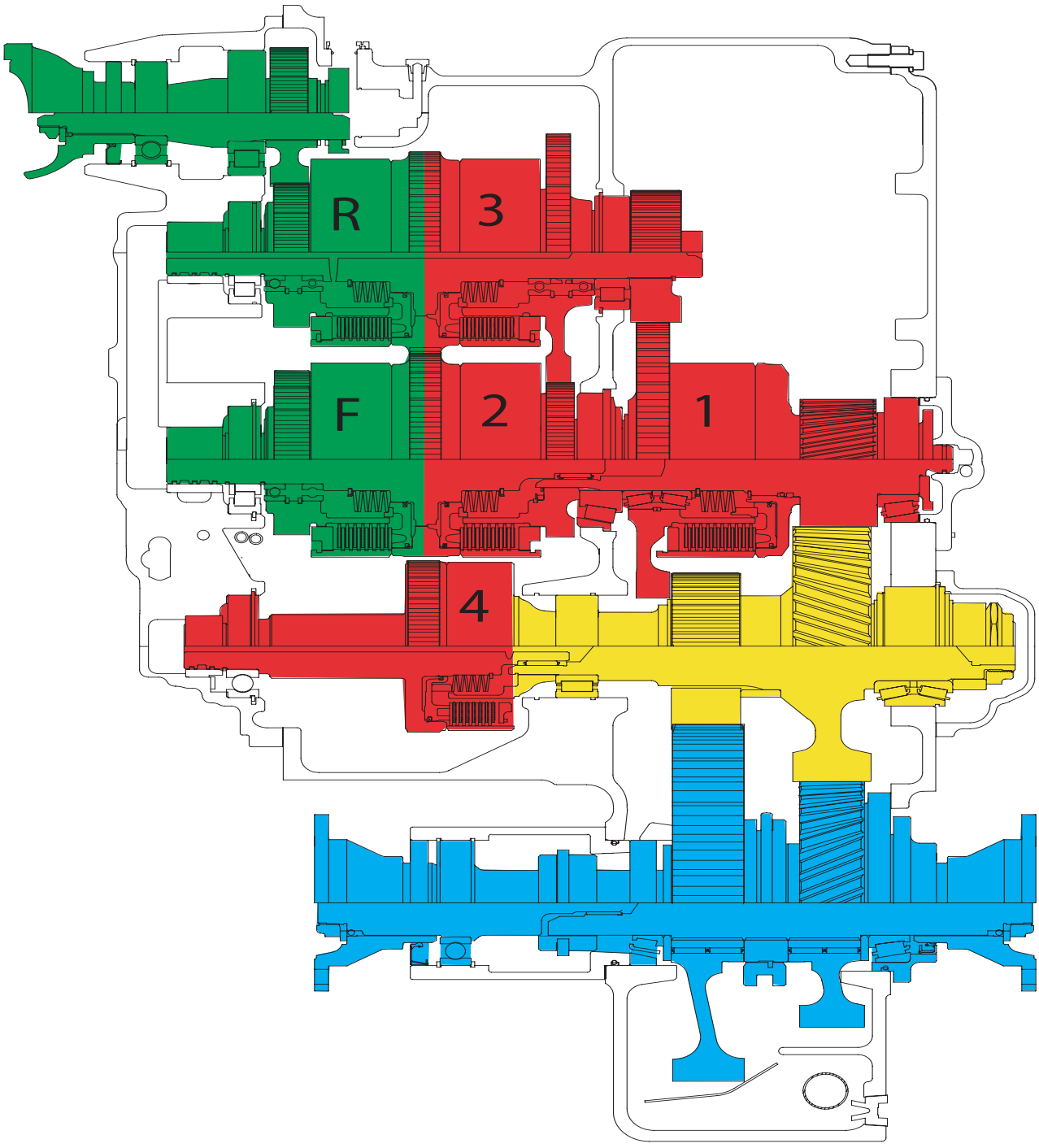
THE SENSOR WIRES HAVE A POLARITY.

BE SURE TO CORRECTLY OBSERVE SENSOR POLARITIES, AS WRONG CONNECTIONS WILL DEACTIVATE THE SENSOR !

6.1 THE TRANSMISSION ASSEMBLY

Basically the transmission is composed of five main assemblies:

1. The idler shaft
2. The input shaft and directional clutches.
3. The range clutches.
4. The output section.
5. The transmission control valve.



6.1.1 THE INPUT SHAFT AND DIRECTIONAL CLUTCHES

The turbine shaft driven from the turbine transmits power to the directional clutch (FWD/REV).
These clutches consist of a drum with internal splines and a bore to receive a hydraulic actuated piston.
The piston is oil tight by the use of sealing rings. The steel discs with internal splines, and friction discs with external splines, are alternated until the required total is achieved.

A back-up plate is then inserted and secured with a retainer ring. A hub with outer diameter splines is inserted into the splines of discs with teeth on the inner diameter. The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.
To engage the clutch, the solenoid will direct oil under pressure through tubes and passages to the selected clutch shafts.

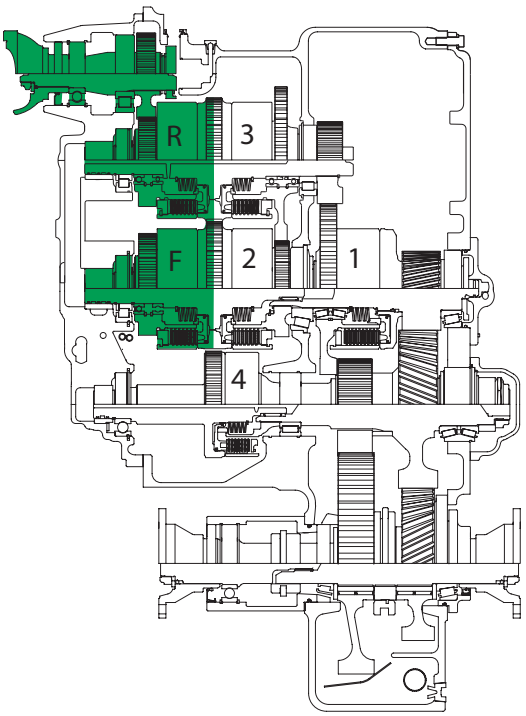
Oil sealing rings are located on the clutch shafts. These rings direct the oil through a drilled passage in the shaft to the desired clutch.

Pressure of the oil forces the piston and discs against the back-up plate. The discs with splines on the outer diameter clamping against discs with teeth on the inner diameter enables the drum and hub to be locked together and allows them to drive as one unit.

When the clutch is released, a return spring will push the piston back and oil will drain back via the shift spool, the bleed valve or holes in the clutch piston into the transmission sump.

These bleed valves will only allow quick escape of oil when the pressure to the piston is released.

(The engagement of all range and directional clutches is modulated and electronically controlled.). This means that clutch pressure is built up gradually. This will enable the unit to make forward, reverse shifts while the vehicle is still moving and will allow smooth engagement of drive.



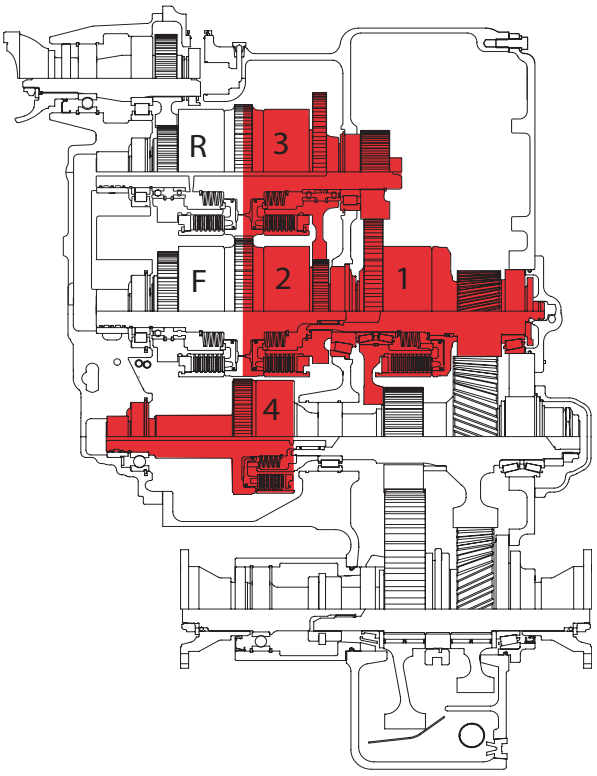
INPUT & DIRECTIONA CLUTCHES

6.1.2 THE RANGE CLUTCHES

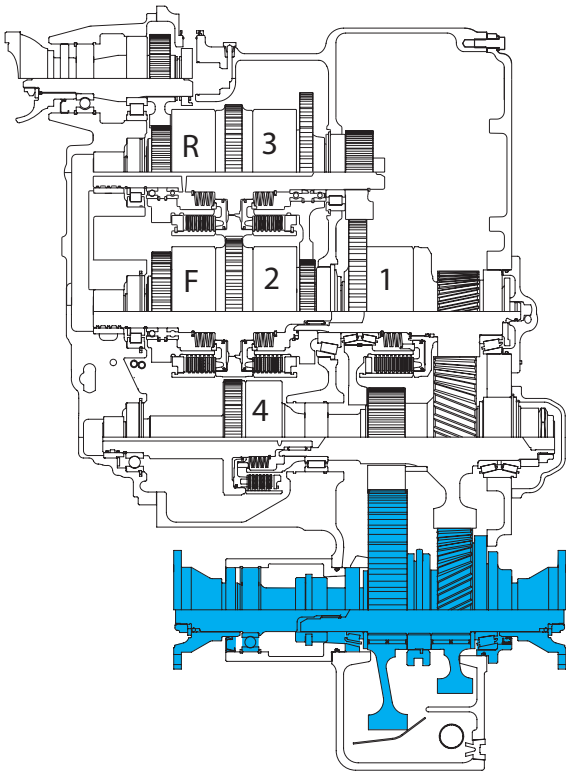
Once a directional clutch is engaged power is transmitted to the range clutches.
Operation and actuation of the range clutches is similar to the directional clutches.
The engagement of the range clutches is modulated.

6.1.3 THE OUTPUT SECTION

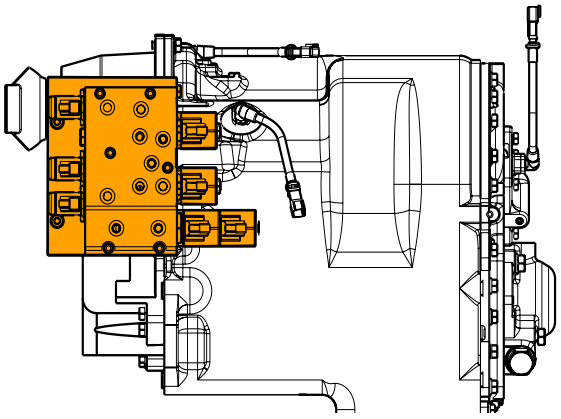
With a range clutch engaged, power is finally transmitted to the output shaft.
Output rotation is the same as the engine rotation when the reverse clutch is engaged.



RANGE CLUTCHES



OUTPUT SHAFT



The Control valve

6.2 THE TRANSMISSION CONTROLS (REFER TO HYDRAULIC DIAGRAM)

The transmission is controlled by the control valve. The control valve assembly is mounted directly on top of the transmission. The function of the control valve assembly is to direct oil under pressure to the desired directional and speed clutches.

6.2.1 OPERATION OF THE VALVE

Regulated pressure 18 bar [261 PSI] is directed to the 5 proportional solenoids.
Each electronic controlled modulation solenoid is current controlled. Meaning that no current corresponds to no pressure, while full current corresponds to full pressure and all variations inbetween.

When actuating the electronic controlled modulation solenoid from 0 mA to 1000 mA, the output pressure will result in a curve from 0 to 18 bar [0-261 PSI] for each directional range clutch.

6.2.2 PRESSURE SENSORS

Each pressure that is coming from the solenoid is measured with a pressure sensor. This is used as a feedback signal for the activation of the solenoids and as a check for the regulated pressure.

6.2.3 ELECTRIC SOLENOID CONTROLS

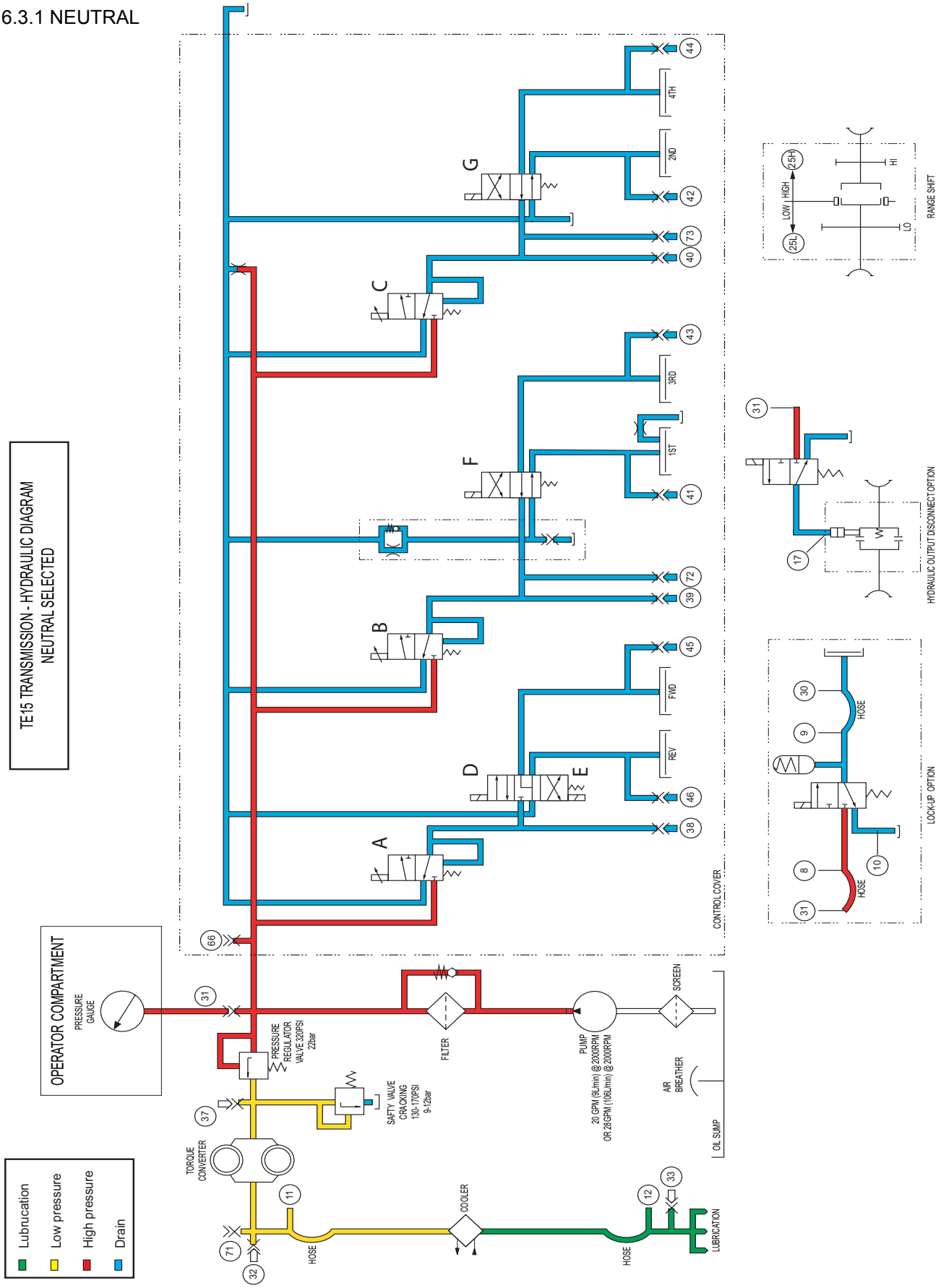
8 SPEED RANGE SHIFT DIAGRAM

	FORWARD								REVERSE								NEUTRAL			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
B	0		0		0		0		0		0		0		0		0		0	
C		0		0		0		0		0		0		0		0		0		0
D	X	X	X	X	X	X	X	X												
E									X	X	X	X	X	X	X	X				
F	X				X				X				X				X			
G		X				X				X				X				X		
RS	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H				

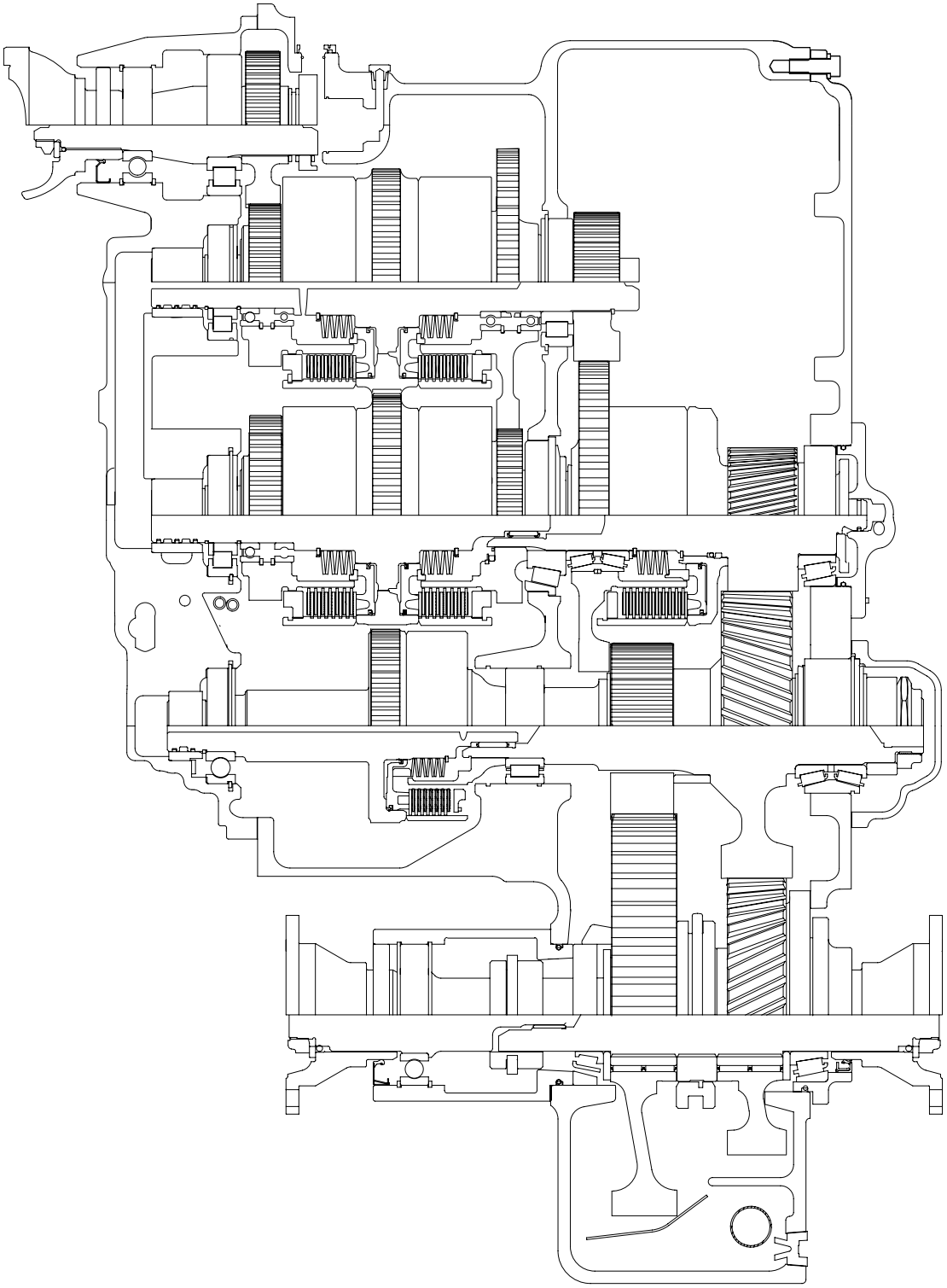
X = Selector solenoid
0 = Proportional solenoid
L = Low range shift position
H = High range shift position

6.3 POWERFOWS, ACTIVATED SOLENOIDS AND HYDRAULIC CIRCUIT

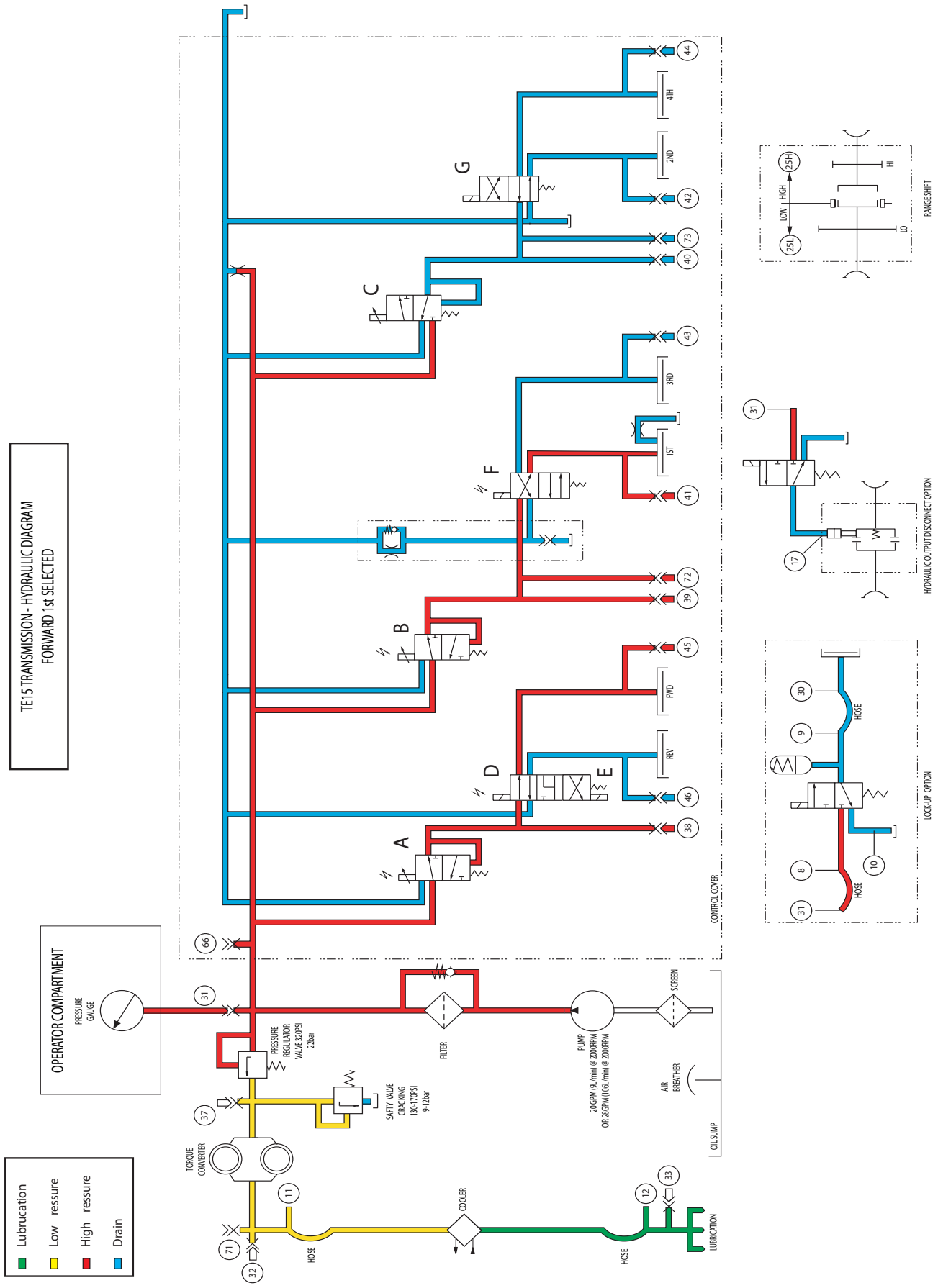
6.3.1 NEUTRAL



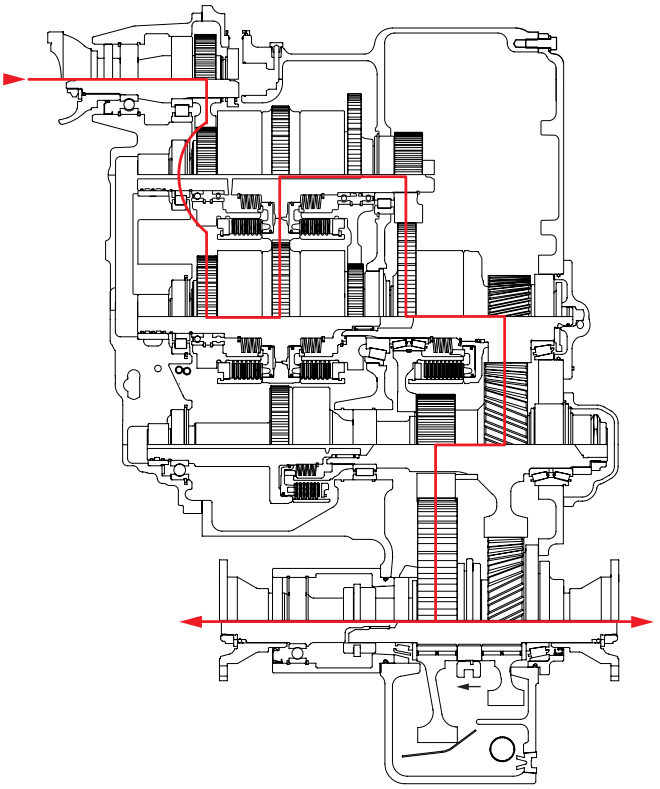
6.3.1 NEUTRAL (CONTINUED)



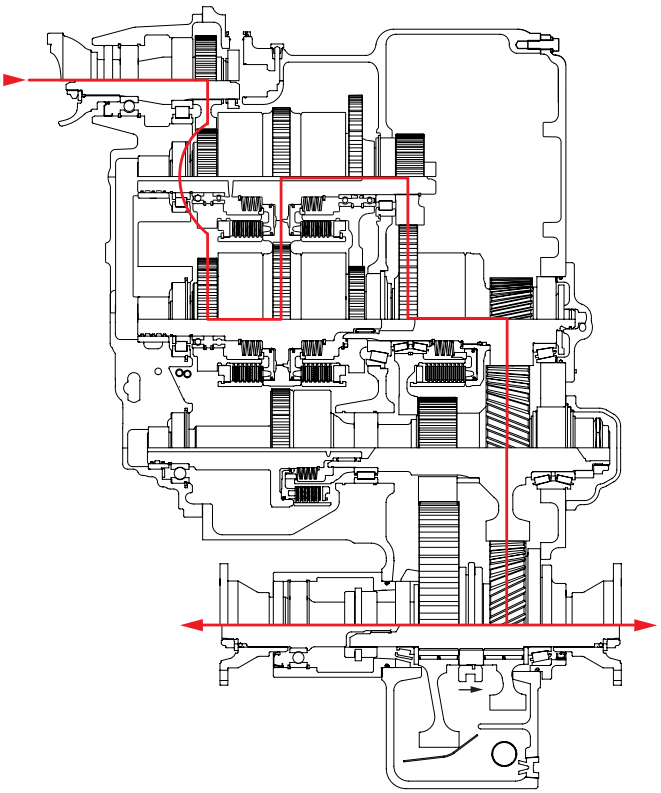
6.3.2 FORWARD 1ST



6.3.2 FORWARD 1ST (CONTINUED)

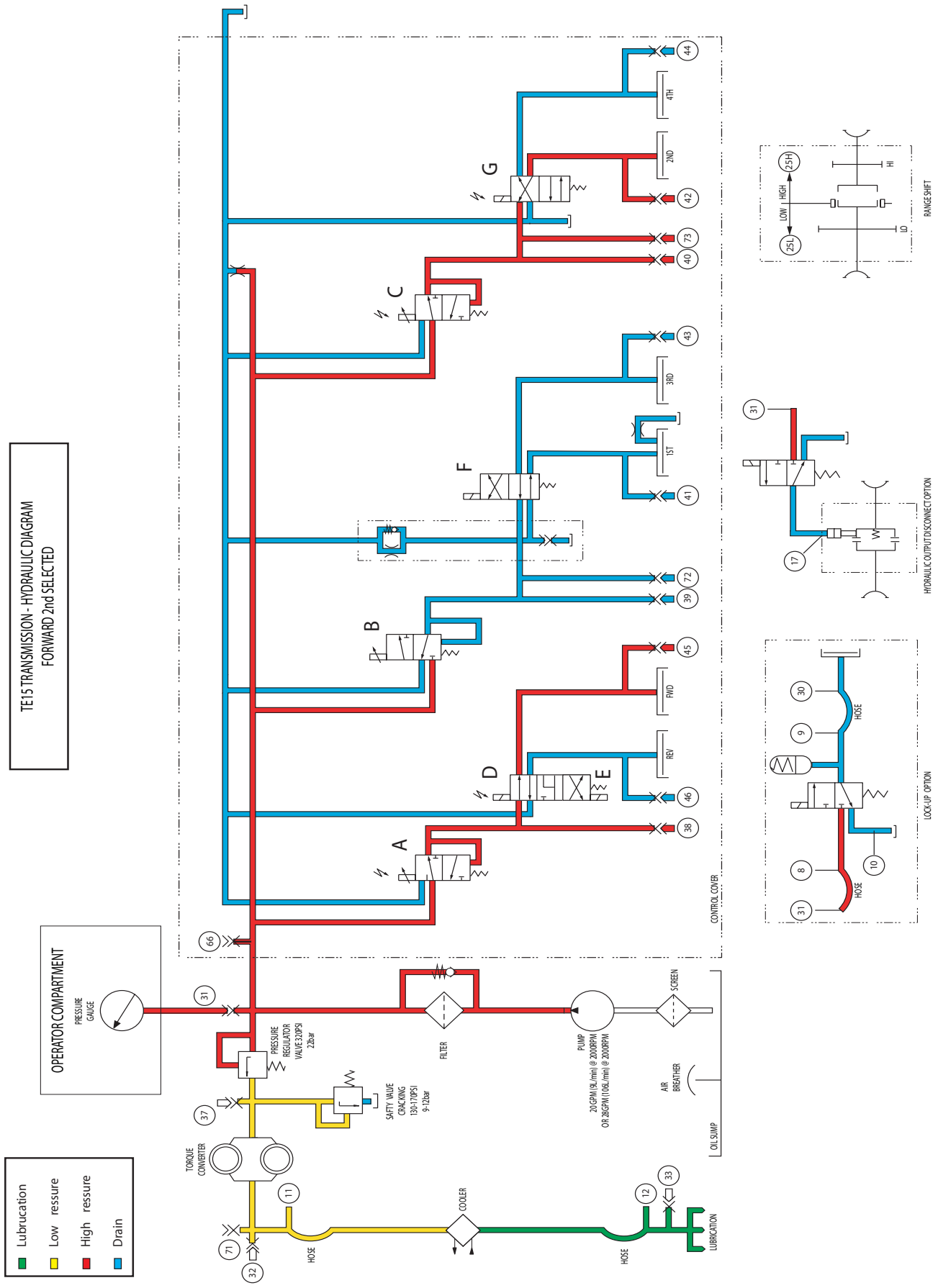


LOW

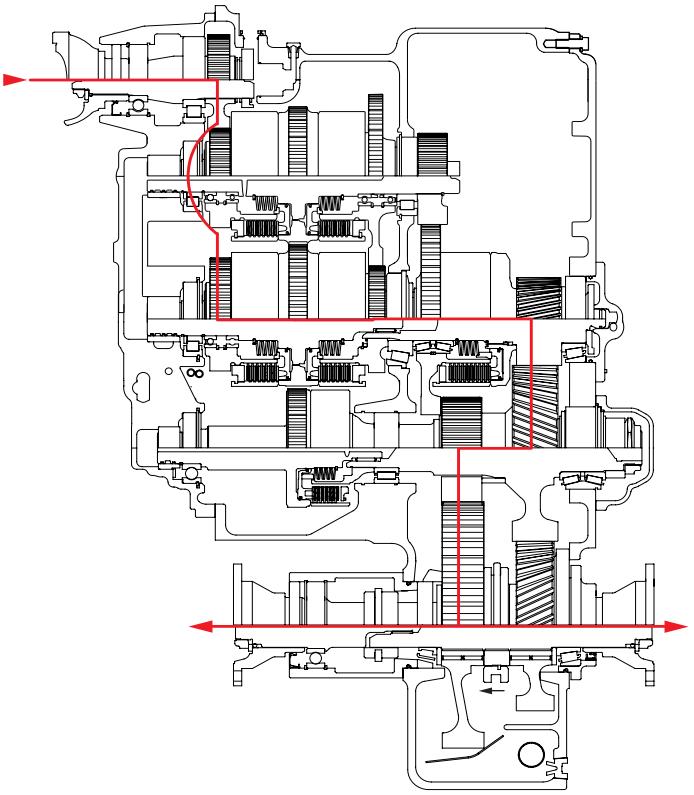


HIGH

6.3.3 FORWARD 2ND



6.3.3 FORWARD 2ND (CONTINUED)



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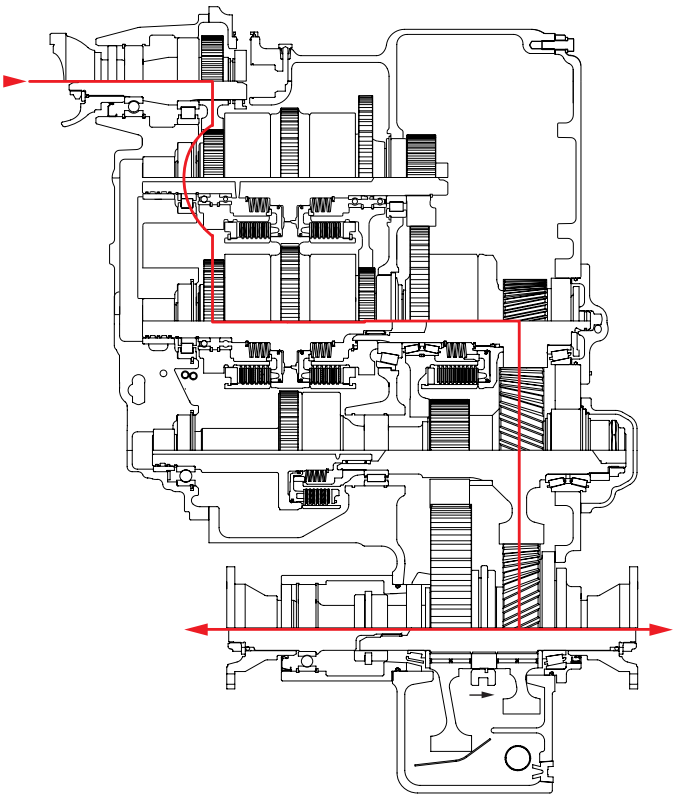
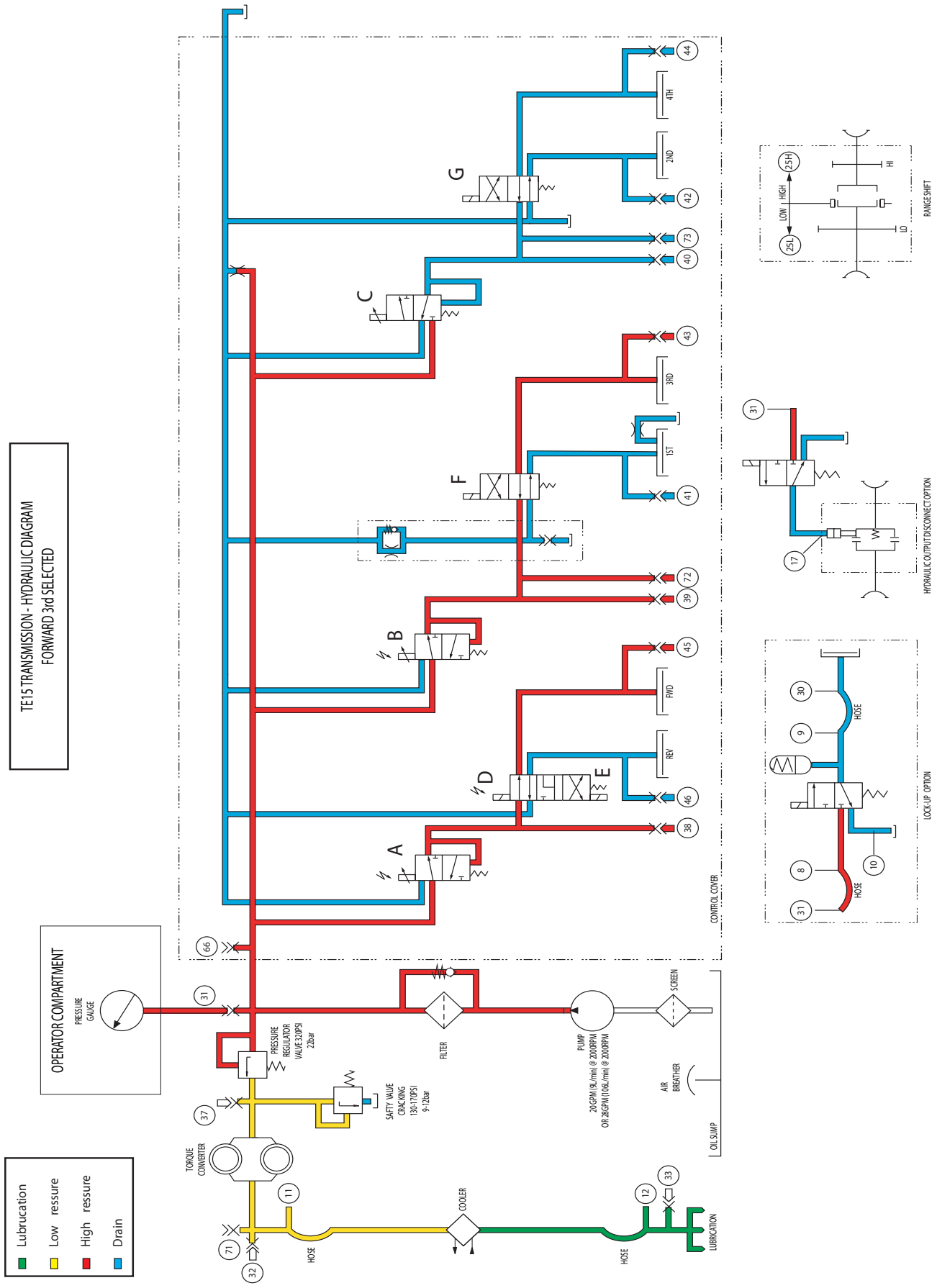
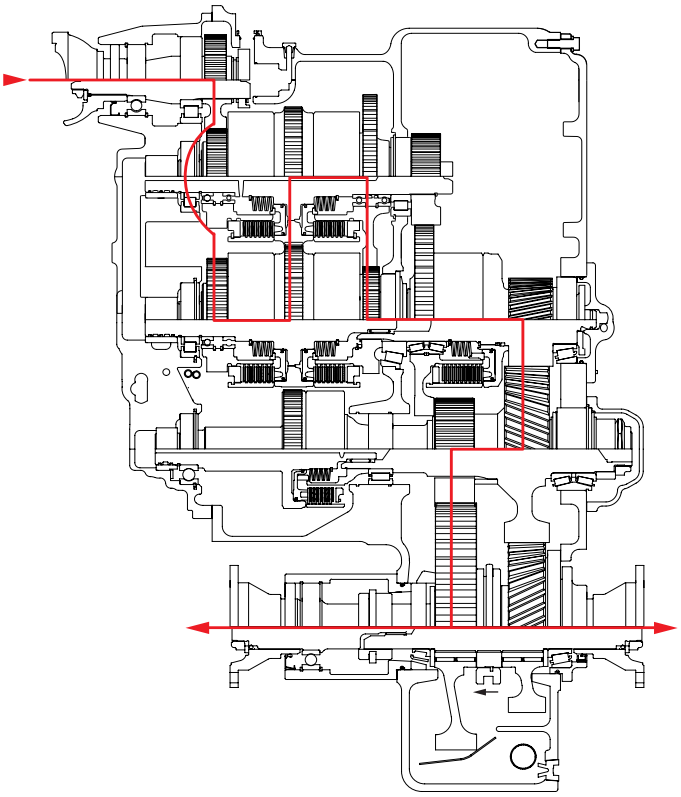


HIGH

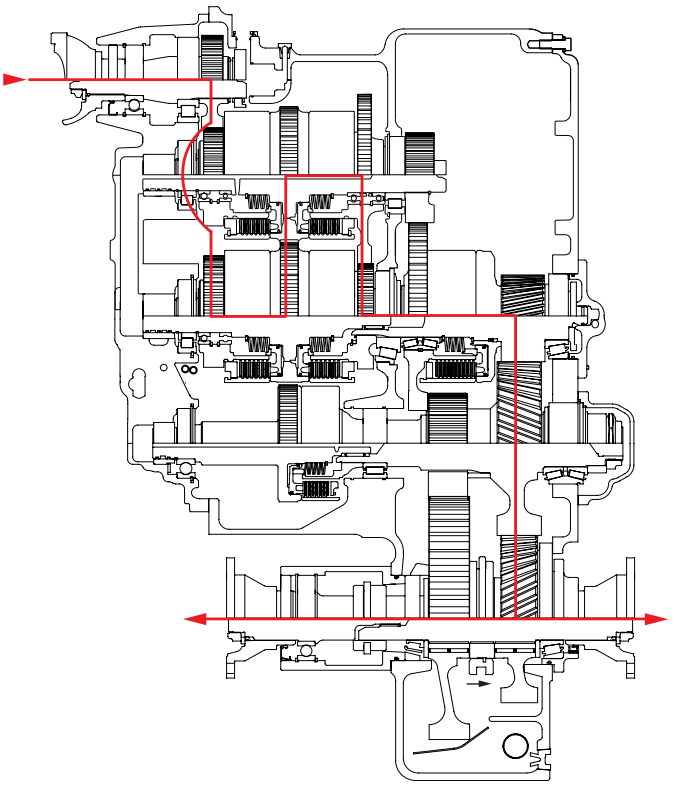
6.3.4 FORWARD 3RD



6.3.4 FORWARD 3ND (CONTINUED)

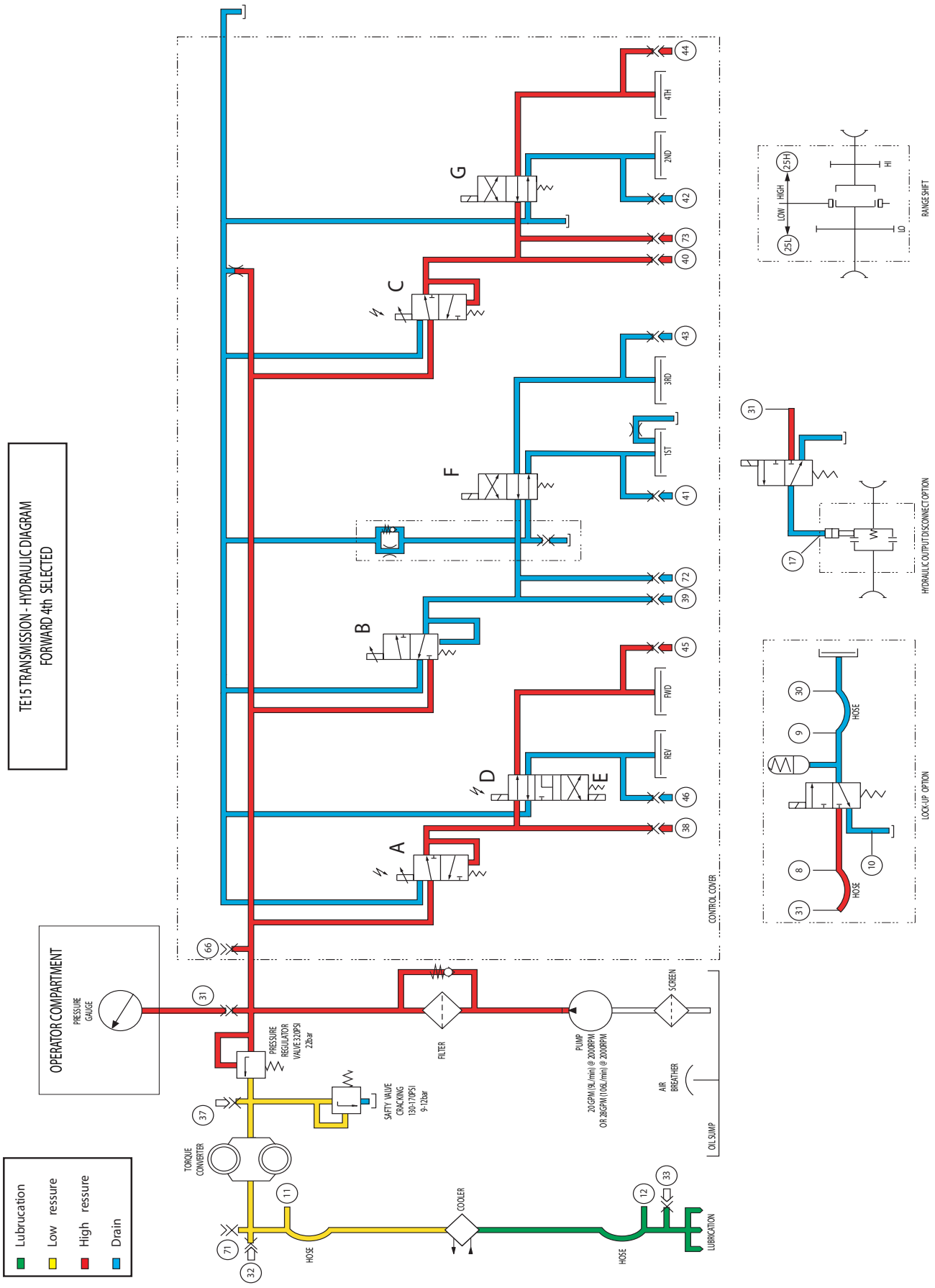


LOW

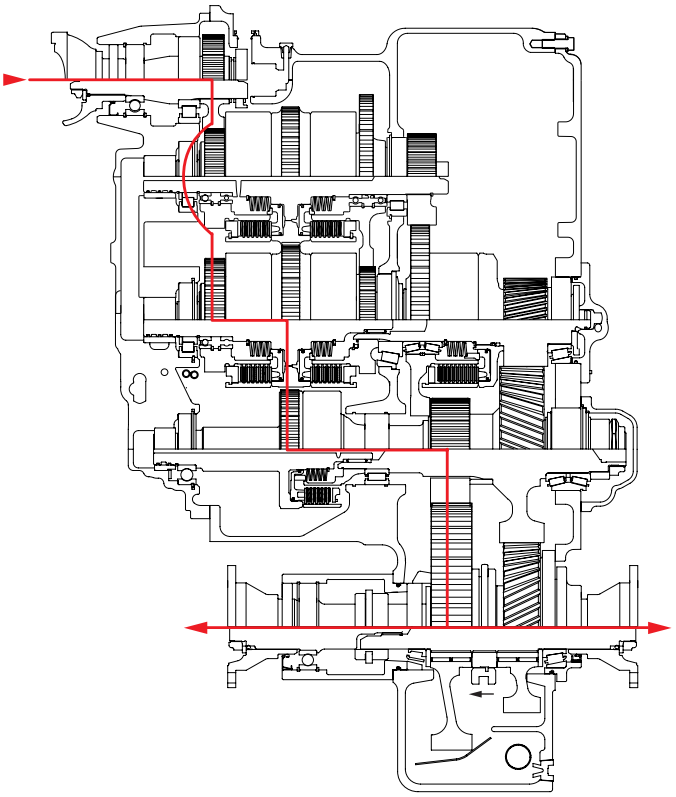


HIGH

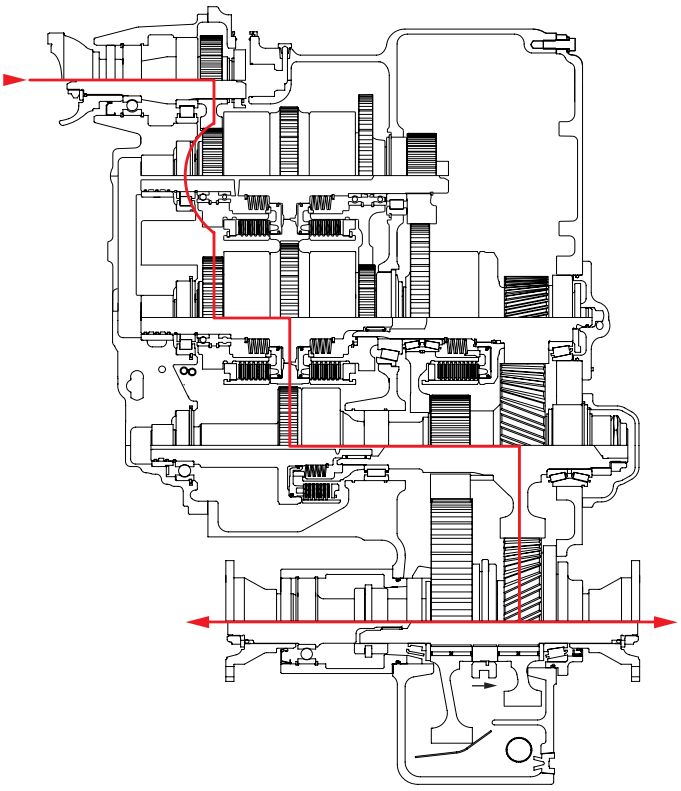
6.3.5 FORWARD 4TH



6.3.5 FORWARD 4TH (CONTINUED)

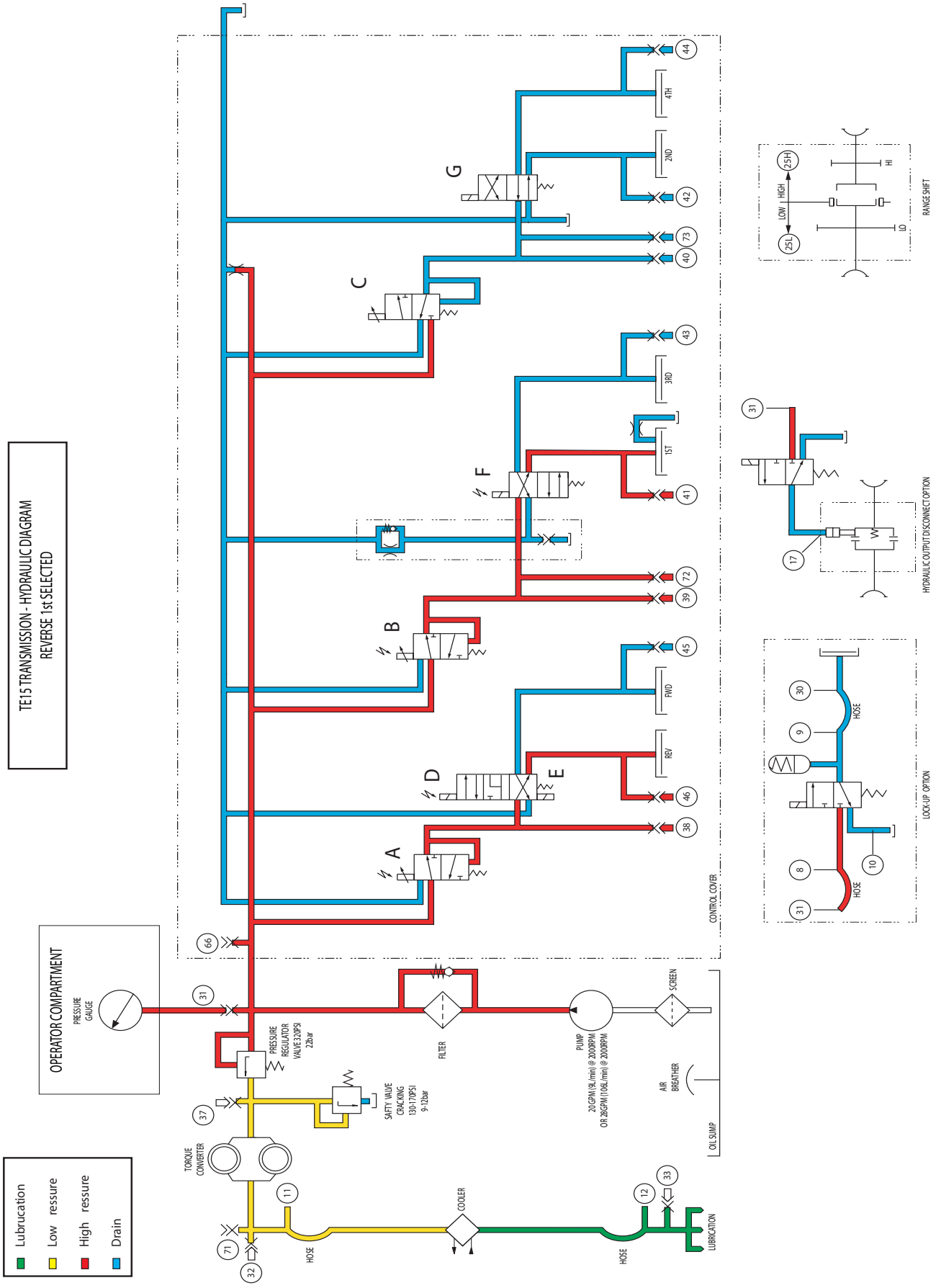


LOW

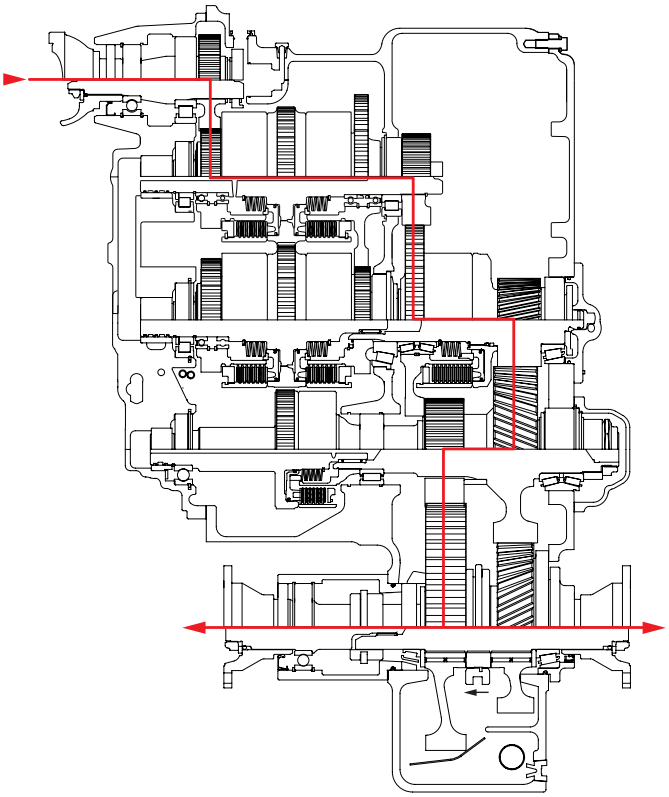


HIGH

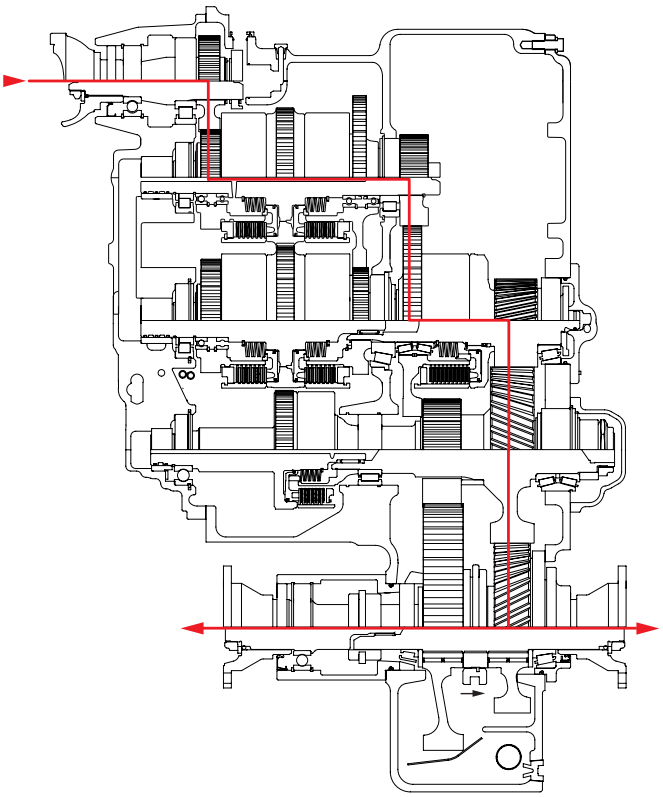
6.3.6 REVERSE 1ST



6.3.5 REVERSE 1ST (CONTINUED)

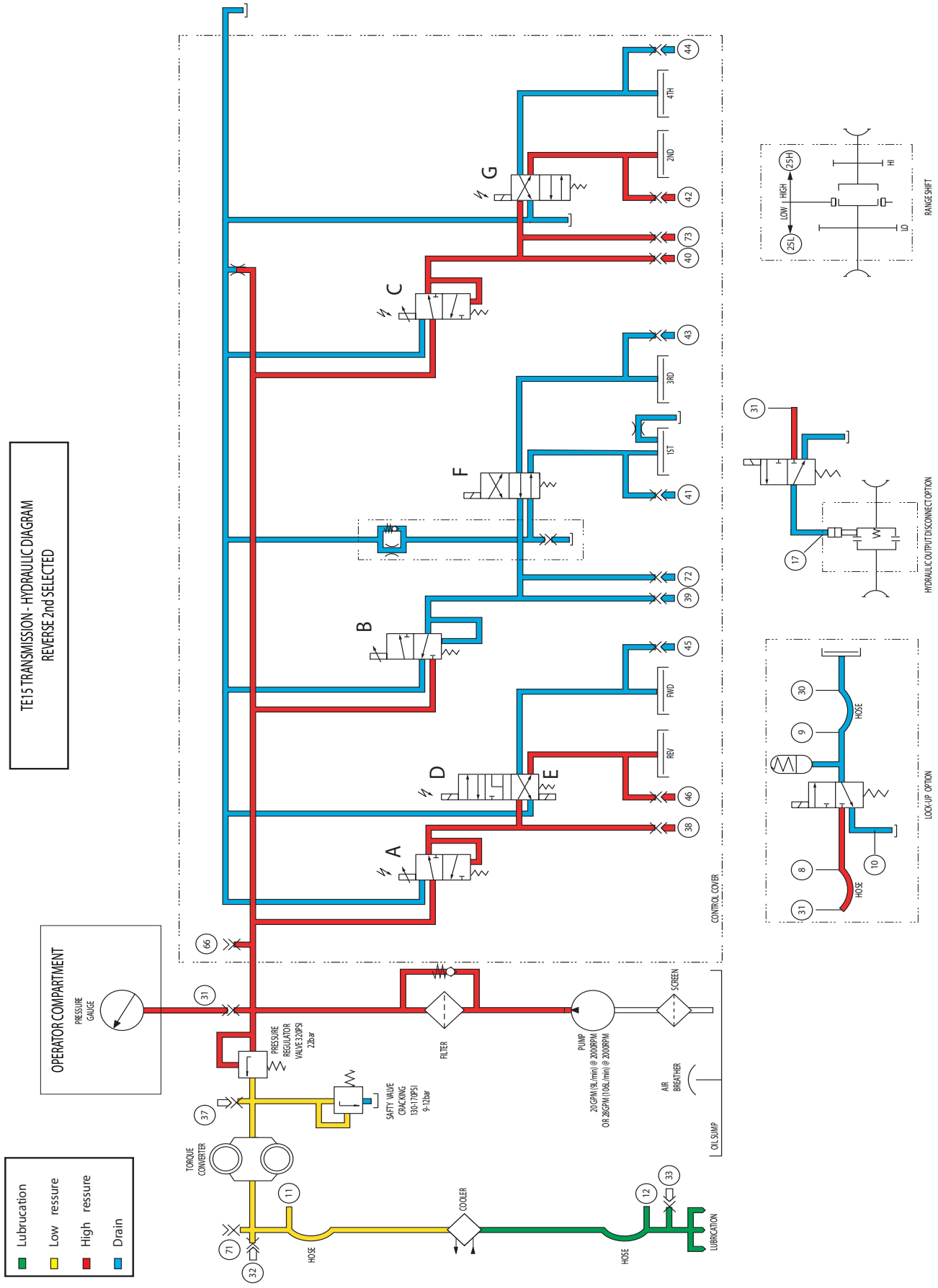


LOW

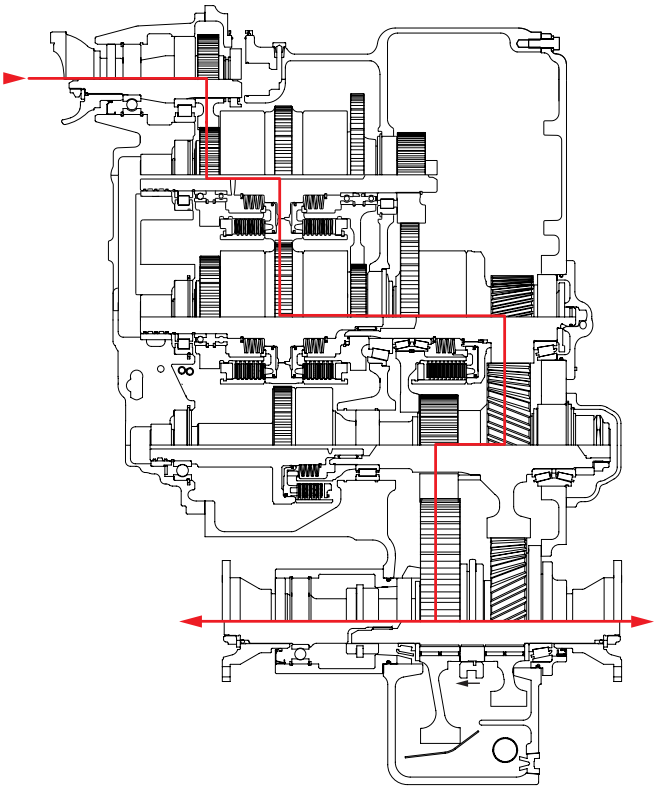


HIGH

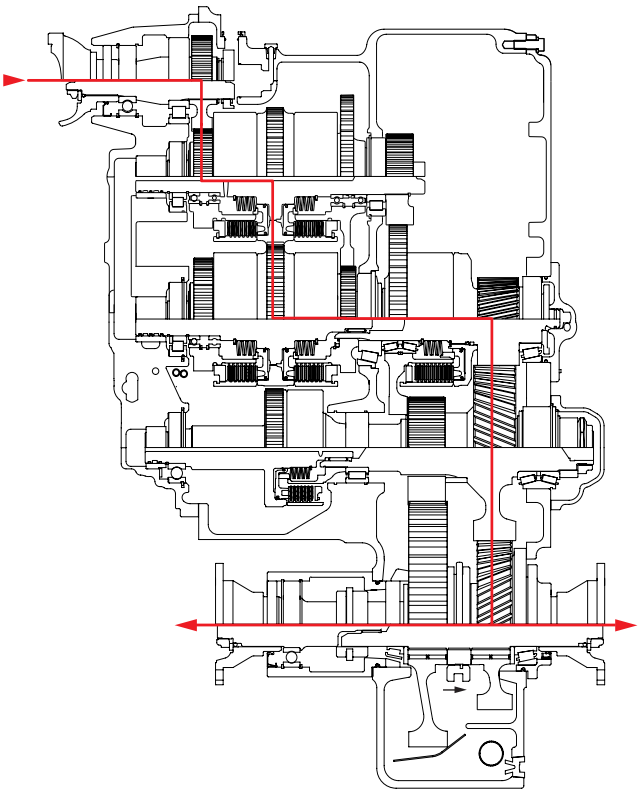
6.3.7 REVERSE 2ND



6.3.7 REVERSE 2ND (CONTINUED)

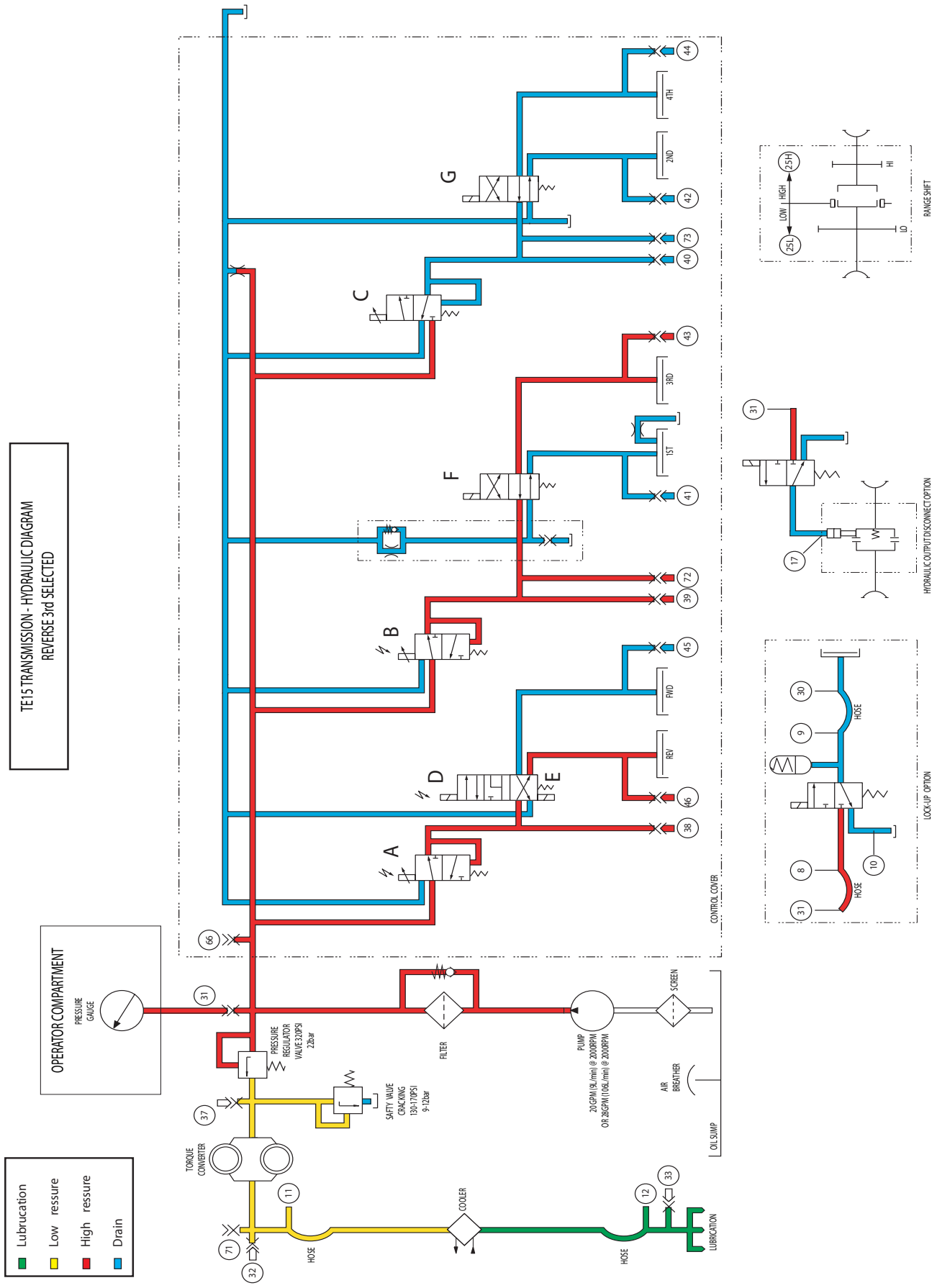


LOW

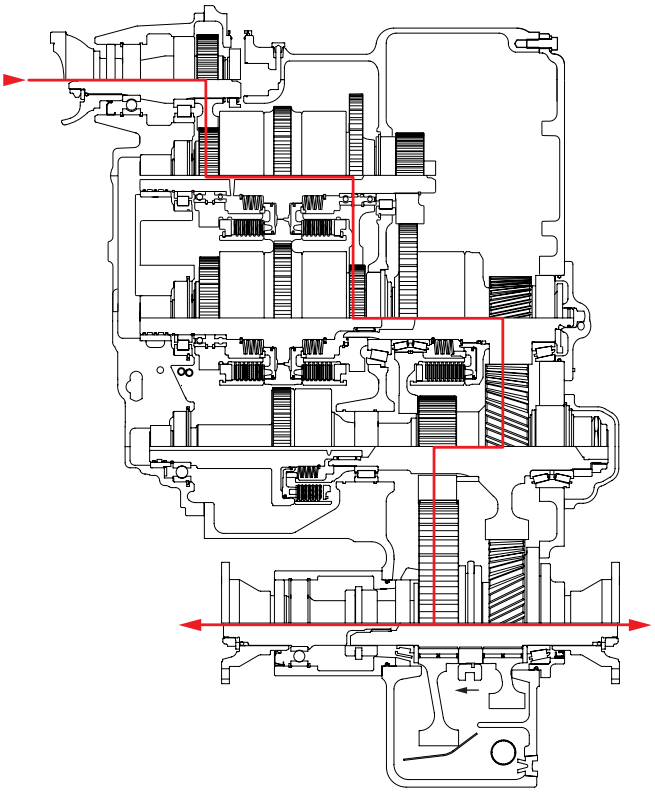


HIGH

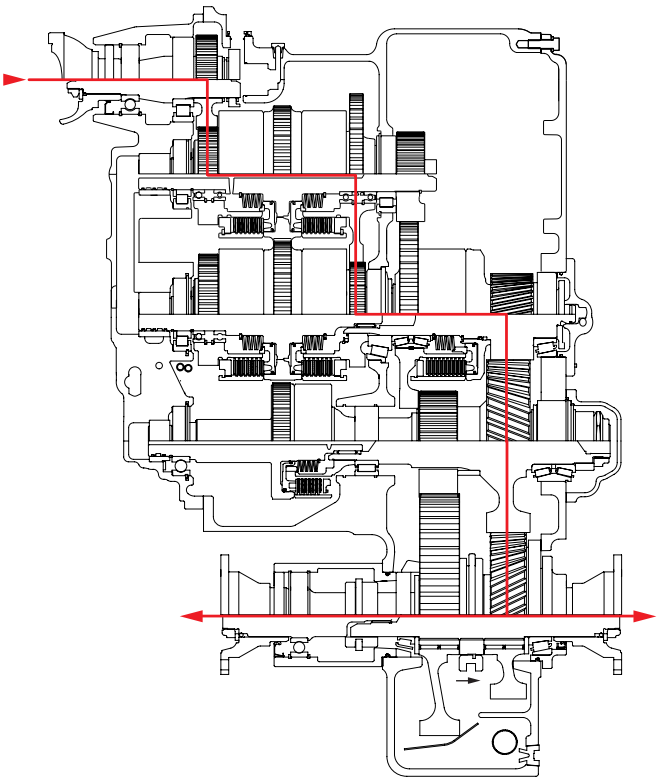
6.3.8 REVERSE 3RD



6.3.8 REVERSE 3RD (CONTINUED)

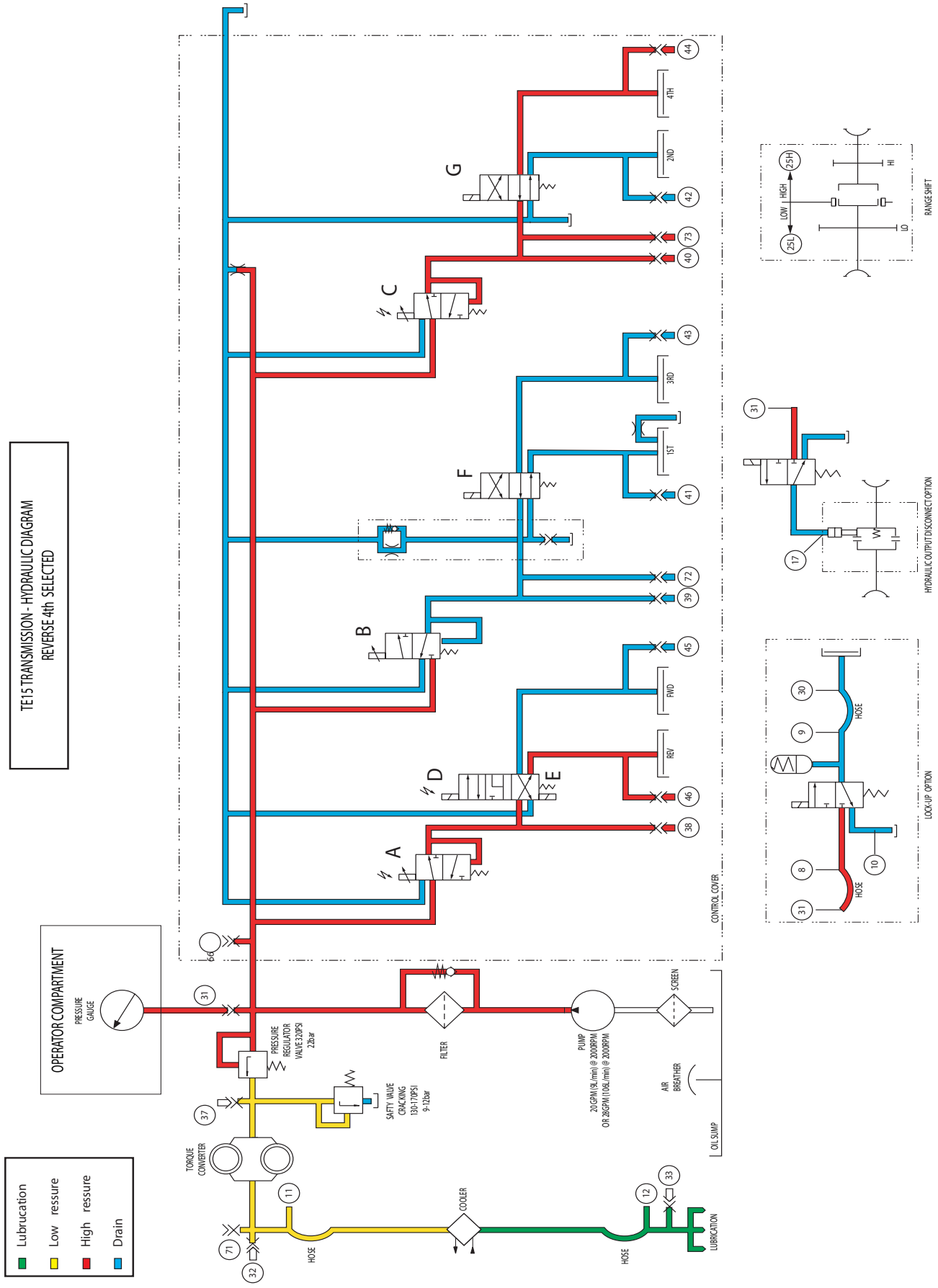


LOW

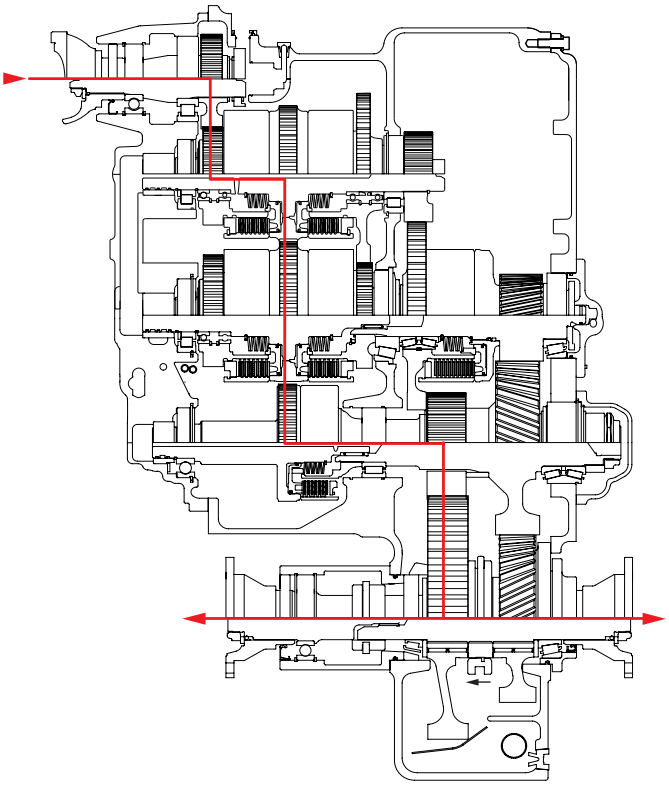


HIGH

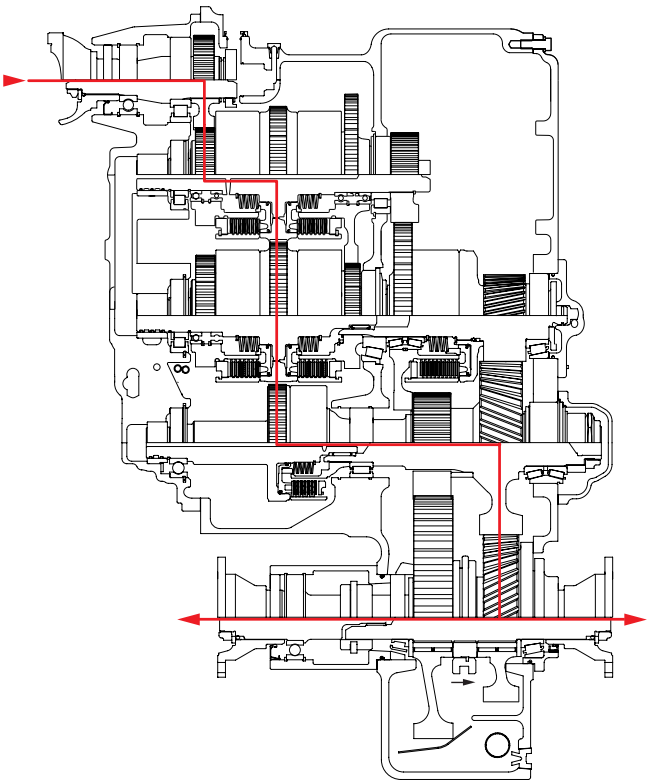
6.3.8 REVERSE 4TH



6.3.8 REVERSE 3RD (CONTINUED)

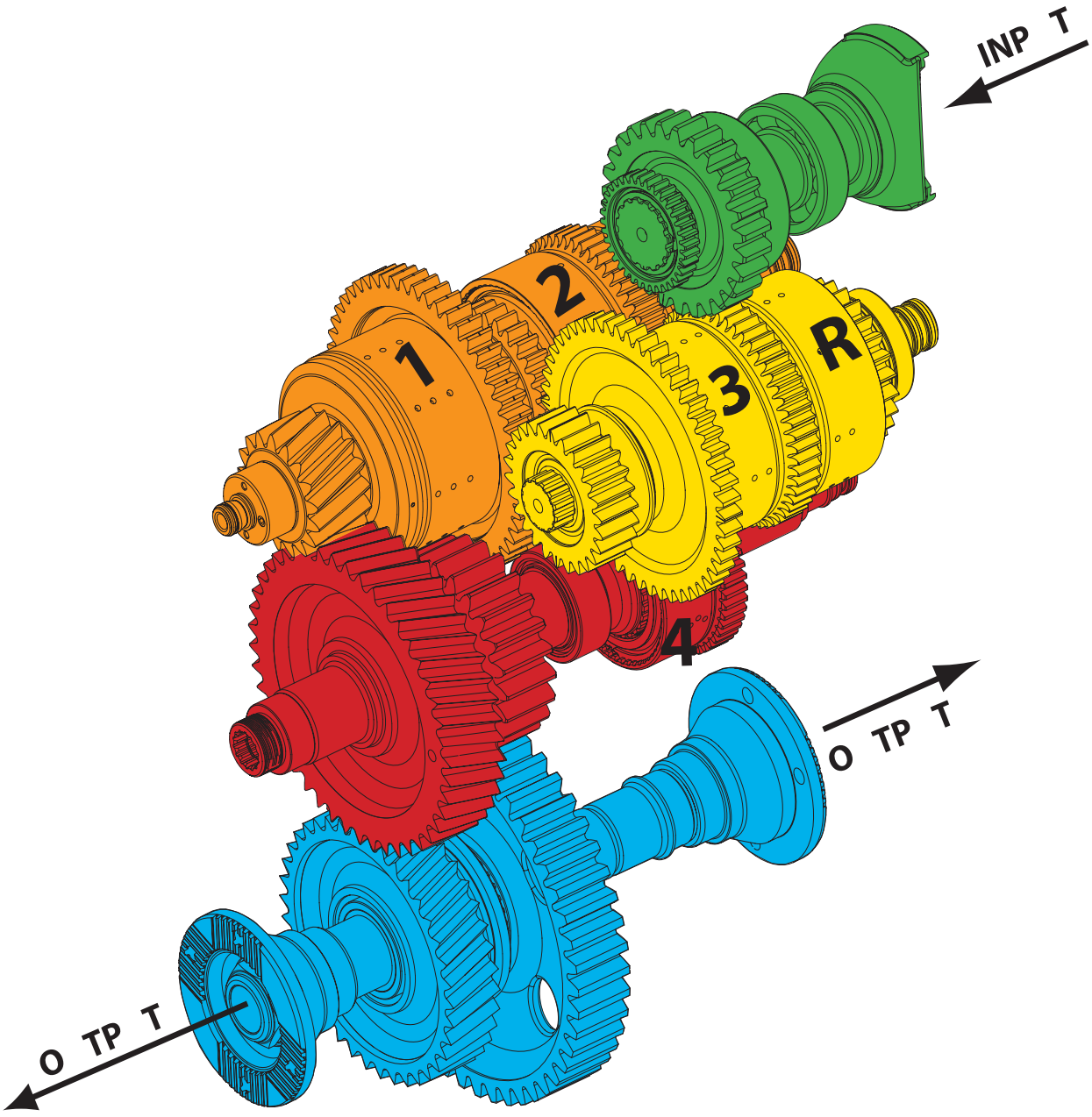


LOW



HIGH

6.4 GEAR CLUTCH LAYOUT



The following information is presented as an aid to isolate and determine the specific problem area in a transmission that is not functioning correctly.

When troubleshooting a “transmission” problem, it should be kept in mind that the transmission is only the central unit of a group of related powertrain components**.** Proper operation of the transmission depends on the condition and correct functioning of the other components of the group.

Therfore, to properly diagnose a suspected problem in the transmission, it is necessary to consider the transmission fluid, charging pump, torque converter, transmission assembly, oil cooler, filter, connecting lines and controls, including the engine as a complete system.

By analysing the principles of operation together with the information in this section, it should be possible to identify and correct any malfunction which may occur in the system.

7.1 The Transmission

TE15 powershift transmission troubles fall into four general categories:

1. Mechanical problems
2. Hydraulical problems
3. Electrical problems
4. Controller problems

In addition to the mechanical and electrical components, all of which must be in proper condition and functioning correctly, the correct functioning of the hydraulic circuit is most important. Transmission fluid is the “life blood” of the transmission. It must be supplied in an adequate quantity and delivered to the system at the correct pressures to ensure converter operation, to engage and hold the clutches from slipping, and to cool and lubricate the working components.

7.2 The input shaft and directional clutches

7.2.1 Stall test

A stall test identifies transmission, converter or engine problems.

Use the following procedure:

1. Put the vehicle against a solid barrier, such as a wall and/or apply the parking brake, block the wheels.
2. Put the directional control lever in FORWARD (or REVERSE, as applicable).
3. Select the highest speed.
With the engine running, slowly increase engine speed to approximately one-half throttle and hold until transmission (converter outlet) oil temperature reaches the operating range. 70°C [158° F]
4. Once the oil temperature reaches 70° C [158° F] check max. stall speed at full throttle in all gears. The figure obtained should be within 50 RPM as mentioned in the vehicle handbook and should be equal in all gears. Between gears allow the converter outlet temperature to cool down. to 70° C [158° F] by selecting neutral.
If max. stall speed measured is below specifications, it could indicate an engine or converter problem. If max. stall speed measured is above specifications, it could indicate slipping clutches.

CAUTION

DO NOT OPERATE THE CONVERTER AT STALL CONDITION LONGER THAN 30 SECONDS AT ONE TIME, SHIFT TO NEUTRAL FOR 15 SECONDS AND REPEAT THE PROCEDURE UNTIL DESIRED TEMPERATURE IS REACHED.

EXCESSIVE TEMPERATURE 120° C [250° F] MAXIMUM WILL CAUSE DAMAGE TO TRANSMISSION CLUTCHES, FLUID, CONVERTER AND SEALS.

7.2.2 Transmission pressure checks

Transmission problems can be isolated by the use of pressure tests. When the stall test indicates slipping clutches, then measure clutch pack pressure to determine if the slippage is due to low pressure or clutch plate friction material failure.
In addition, converter charging pressure and transmission lubrication pressure can also be measured.

7.2.3 Mechanical and electrical checks

Prior to checking any part of the system for hydraulic function (pressure testing), the following mechanical and electrical checks should be made:

- Check the parking brake and inching pedal for correct adjustment.
- Be sure all lever linkage is properly connected and adjusted in each segment and at all connecting points.
- The controls are actuated electrically. Check the wiring and electrical components.
- Be sure that all components of the cooling system are in good condition and operating correctly. The radiator must be clean to maintain proper cooling and operating temperatures for the engine and transmission. Air clean the radiator, if necessary.

7.2.4 Hydraulic checks

Also, before checking the transmission clutches, torque converter, charging pump and hydraulic circuit for pressure and rate of flow, it is imporatant to make the following transmission fluid check:

- Check oil level in the transmission. The transmission fluid must be at the correct (full level).
- All clutches and the converter and its fluid circuit lines must be fully charged (filled) at all times.

Note:

THE TRANSMISSION FLUID MUST BE AT OPERATING TEMPERATURE OF 82 - 93° C [180 - 200° F] TO OBTAIN CORRECT FLUID LEVEL AND PRESSURE READINGS.

DO NOT ATTEMPT TO MAKE THESE CHECKS WITH COLD OIL.

To raise the oil temperature to this specification it is necessary to either operate (work) the vehicle or run the engine with converter at “stall” (refer to 7.2.1 “stall test”).

Caution:

BE CAREFULL THAT THE VEHICLE DOES NOT MOVE UNEXPECTEDLY WHEN OPERATING THE ENGINE AND CONVERTER AT STALL RPM.

7.2.5 Controller (APC200): Please refer to functional description

7.3 TROUBLESHOOTING GUIDE

Refer to the following troubleshooting guide for the diagnosis of typical transmission troubles

7.3.1 Low clutch pressure

Cause	Remedy
1. Low oil level.	1. Fill to proper level.
2. Clutch pressure regulating valve stuck open.	2. Clean valve spool and housing.
3. Faulty charging pump.	3. Replace pump.
4. Broken or worn clutch shaft or piston sealing rings	4. Replace sealing rings.
5. Clutch piston bleed valve stuck open.	5. Clean bleed valve thoroughly.

7.3.2 Low charging pump output flow

Cause	Remedy
1. Low oil level.	1. Fill to proper oil level.
2. Suction screen clogged.	2. Clean suction screen.
3. Defective charging pump.	3. Replace charging pump.

7.3.3 Overheating

Cause	Remedy
1. Worn oil sealing rings converter	1. Remove, disassemble and rebuild assy
2. Worn charging pump.	2. Replace charging pump.
3. Low oil level.	3. Fill to proper level.
4. Dirty oil cooler.	4. Clean cooler.
5. Restriction in cooler lines.	5. Change cooler lines.

7.3.4 Noisy converter

Cause	Remedy
1. Worn charging pump.	1. Replace charging pump.
2. Worn or damaged bearings. to	2. A complete disassembly will be necessary determine which bearing is faulty.

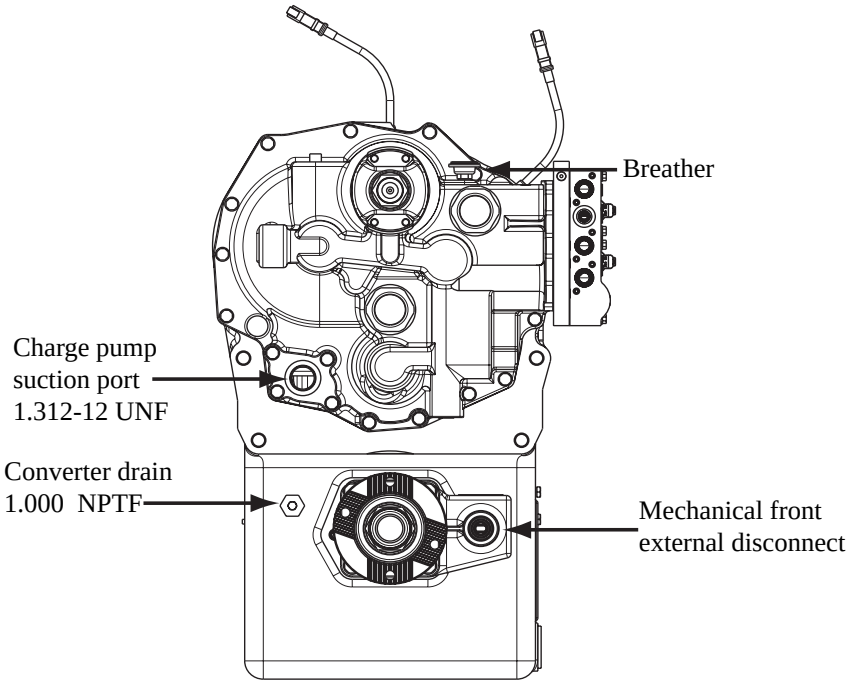
7.3.5 Lack of power

Cause	Remedy
1. Low engine RPM at converter stall.	1. Tune engine, check governor.
2. See “Overheating” and make same checks.	2. Make corrections as explained in “Overheating”.

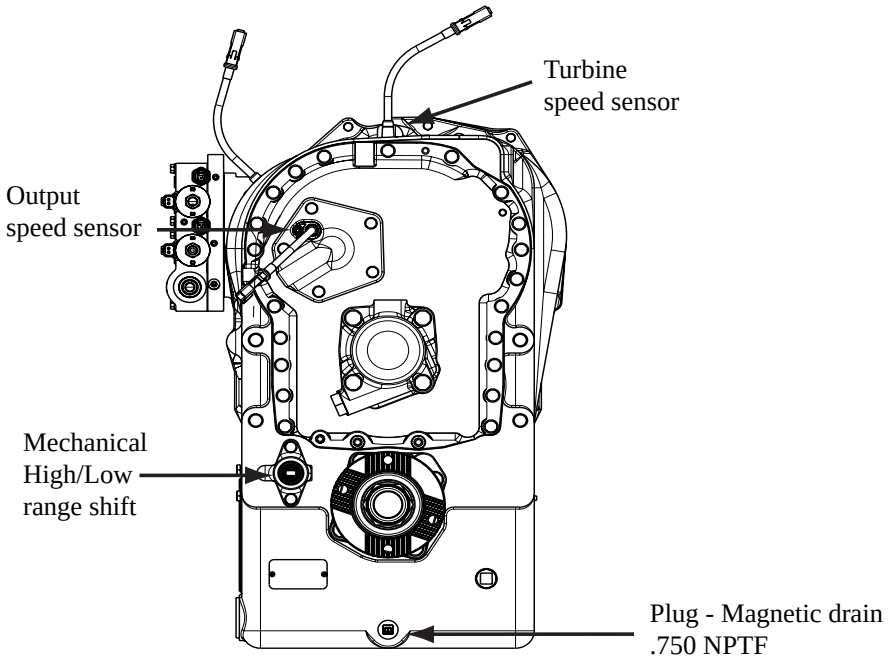
CONVENTION TABLE
in numbering of ports for Hydraulic Circuit Diagrams

PORTS	PRESSURE CHECK PORTS	TEMPERATURE CHECK PORTS
1	31 Regulated Clutch	71 To Cooler
2	32 To Cooler	72 1st/3rd Temp sensor
3	33 From Cooler	73 2nd/4th Temp sensor
4	34 Lube (& Safety Valve)	74 Brake temp
5	35 Pump	75
6 Brake apply	36 Solenoid	76
7 Hydr brake lube	37 Converter In	77
8 To Lock-up valve	38 Fwd/Rev mod pressure	78
9 From Locj-up valve	39 1st/3rd mod pressure	79
10 Lock-up valve drain	40 2nd/4th mod pressure	80
11 To Cooler	41 1st Clutch	81
12 From Cooler	42 2nd Clutch	82
13 To Remote Filter (on Transmission)	43 3rd Clutch	83
14 From Transmission (on Remote Filter)	44 4th Clutch	84
15 To Transmission (on Remote Filter)	45 FWD Clutch	85
16 From remote Filter (on Transmission)	46 REV Clutch	86
17 Air/Hydr Disconnect - 4WD	47 Disconnect Clutch	87
18 To Pump	48 Clutch Return Line	88
19 Air/Hydr Inching	49 SAHR Brake Release	89
20 Air/Hydr Disconnect - 2WD	50 VFS 1st	90
21 From Pump	51 VFS 2nd	
22 Drain	52 VFS 3rd	
23 From Regulator	53 VFS High	
24 SAHR brake Release	54 VFS FWD	
25 Range - Shift	55 VFS REV	
26 Diff. Lock	56 System Pressure (after Total Neutral)	
27 Power Brake Supply	57 Pilot Pressure	
28 Clutch Return Line	58 Pressure Check Range Clutches	
29 From Pump for Brake Release	59 Pressure Check Direct. Clutches	
30 Lock-up apply	60 Pressure Intensifier 1st	
	61 Pressure Intensifier 2nd	
	62 Pressure Intensifier 3rd	
	63 Pressure Intensifier High	
	64 Pressure Intensifier FWD	
	65 Pressure Intensifier REV	
	66 Clutch supply pressure	

7.4 CHECK POINTS

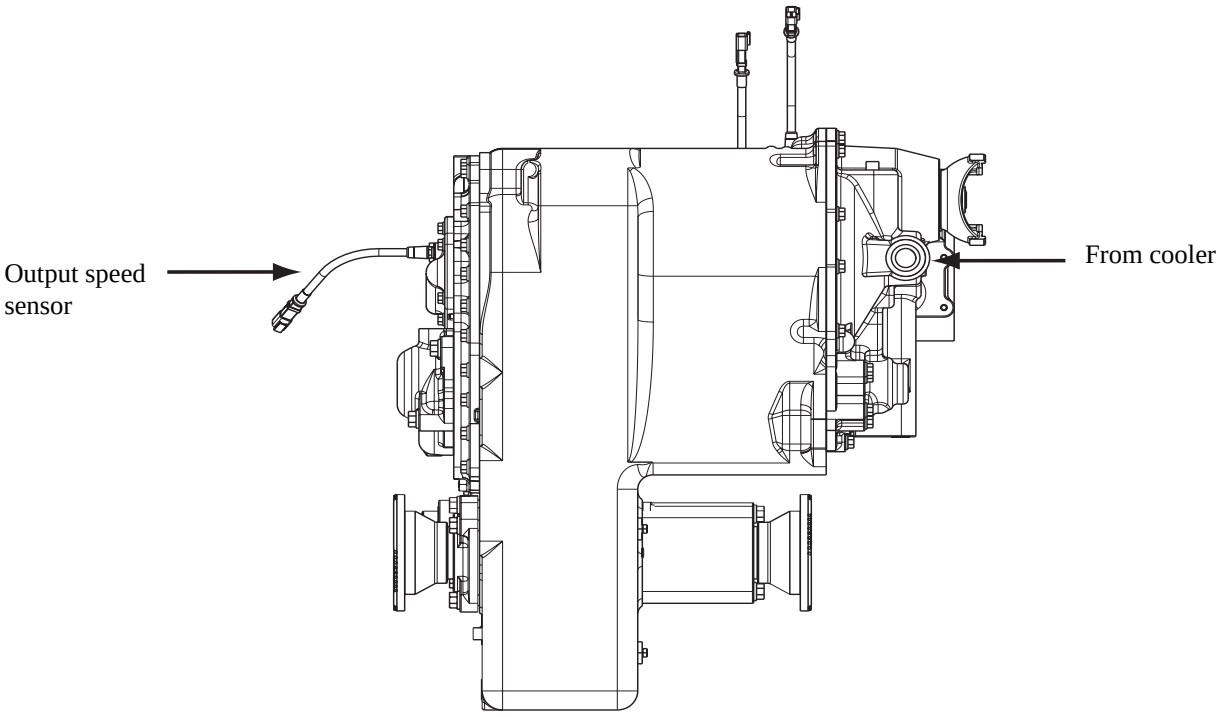


FRONT VIEW

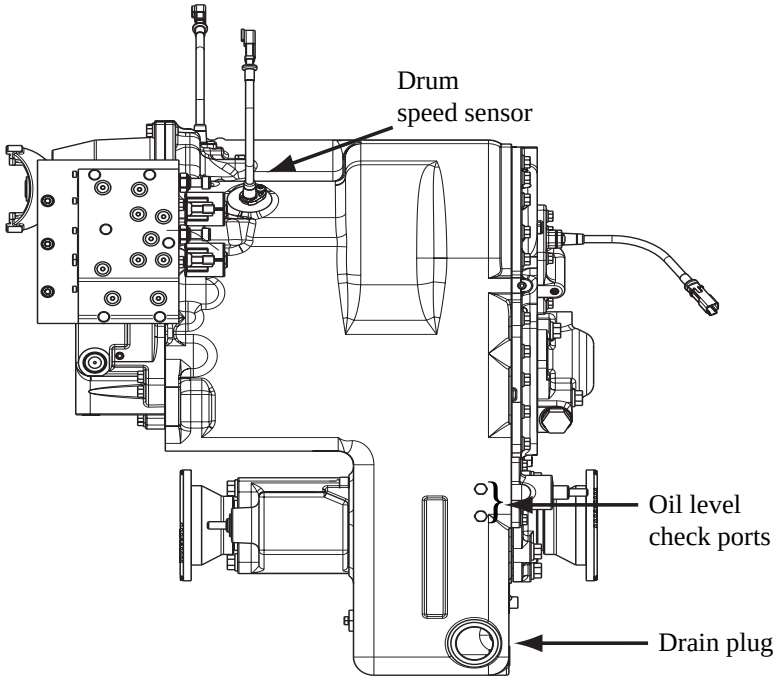


REAR VIEW

7.4 CHECK POINTS (continued)

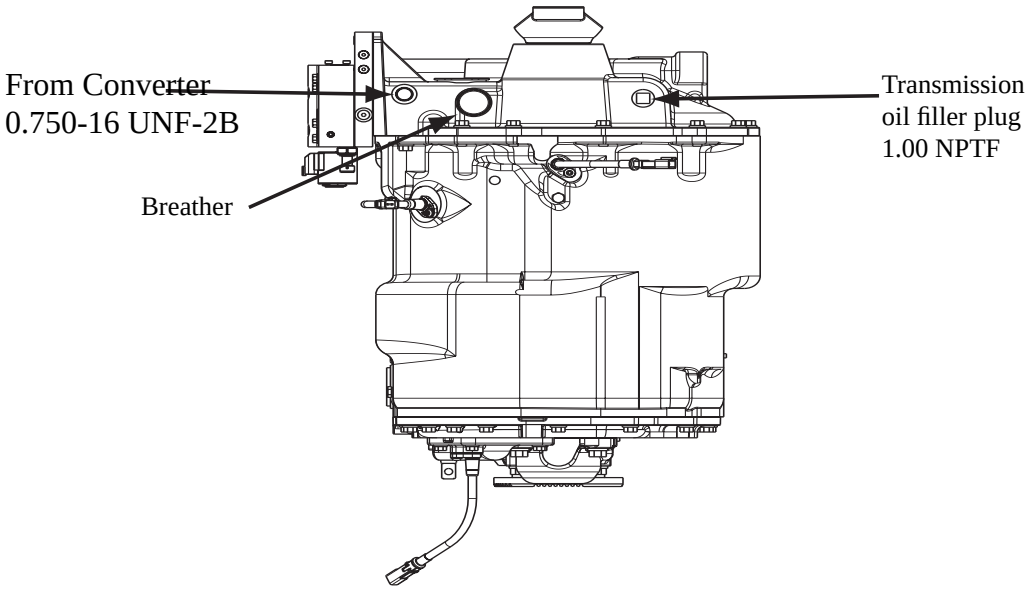


RIGHT VIEW

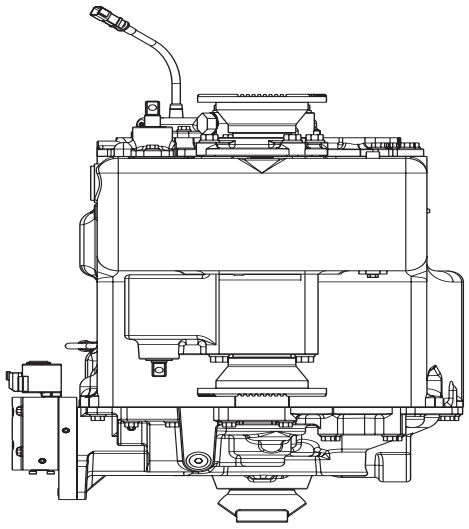


LEFT VIEW

7.4 CHECK POINTS (continued)



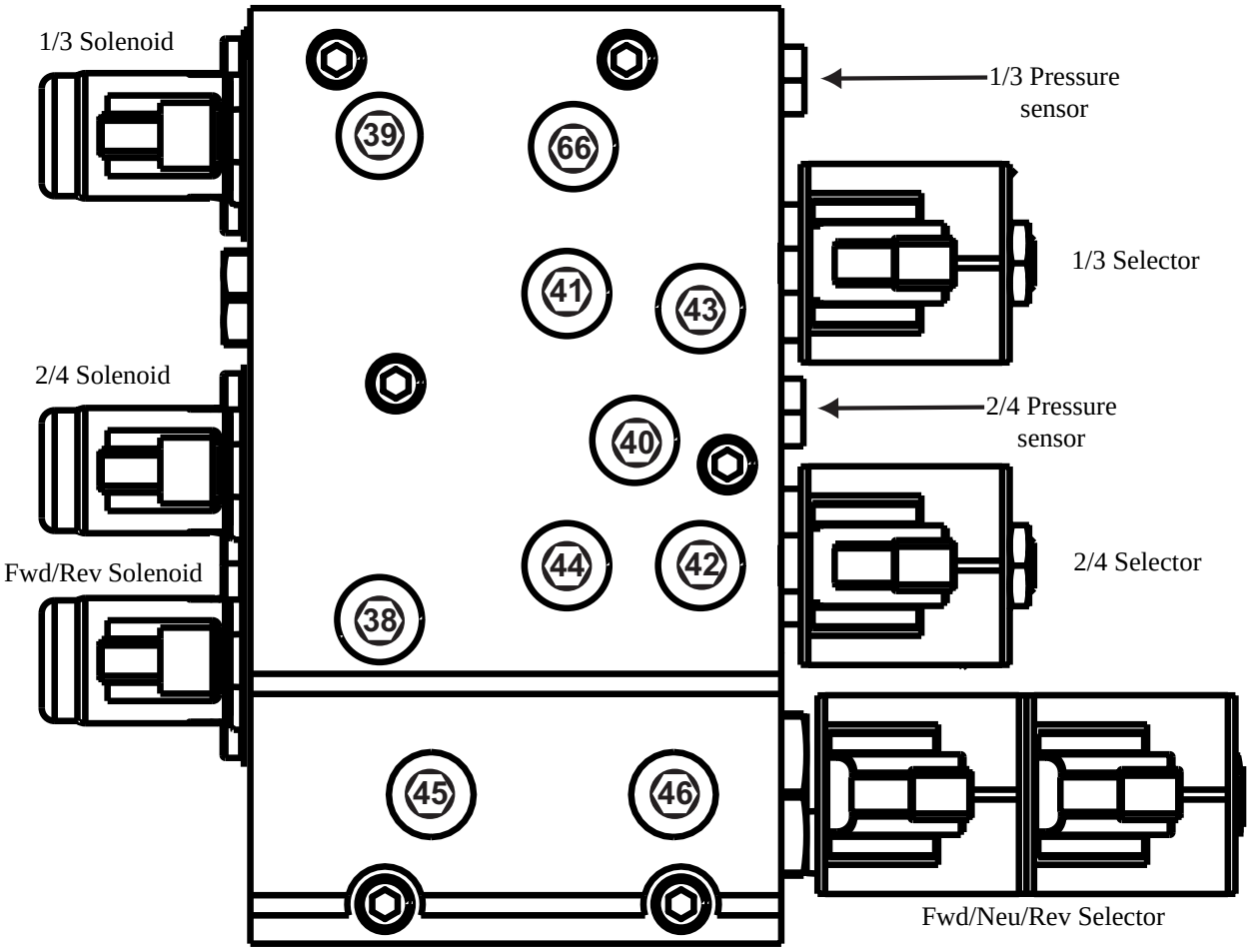
TOP VIEW



BOTTOM VIEW

7.4 CHECK POINTS (continued)

(See also Convention table in numnering ports)



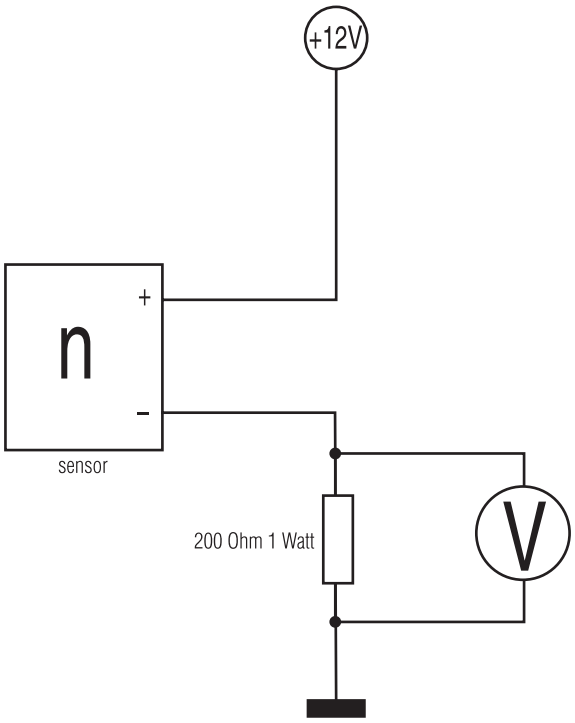
7.6 SPEED SENSOR - STATIC STANDALONE TEST

In order to be able to sense the currents, a series resistor of e.g. 200 Ω must be used. This resistor is integrated in the controller, but when the sensor is to be used, it must be connected externally.

The idea is to connect the sensor to an external power source and measure the DC voltage across the series resistor.

The voltage reading should be either 1.2V (from the 7mA ± 1mA current level) or 2.6 - 3.0V (for the 14mA ± 1mA current level).

If the teeth can be moved slowly, distinct toggling between the two levels should be noticed.

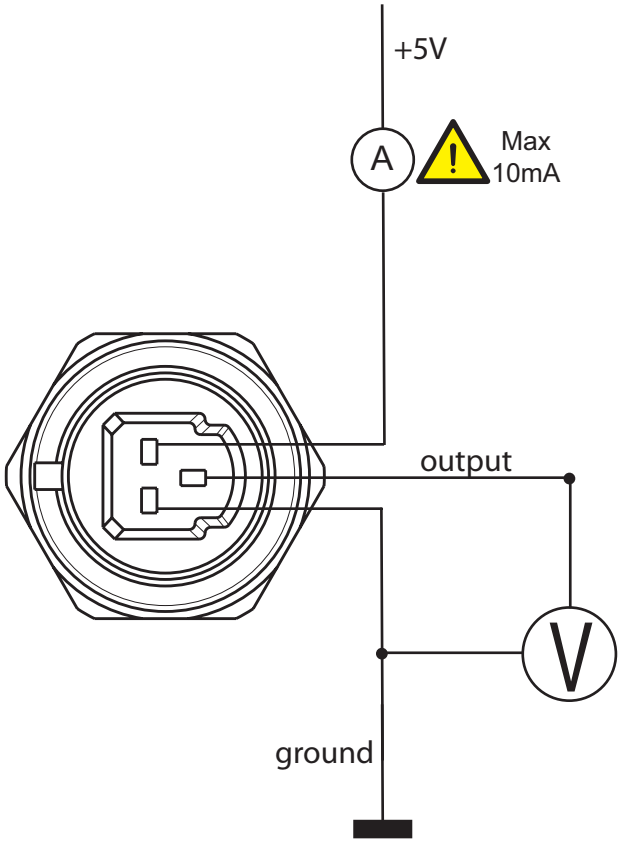


7.8 PRESSURE SENSOR - STANDALONE TEST

In order to be able to test the pressure sensor without the transmission controller, you have to perform a test as per procedure below;

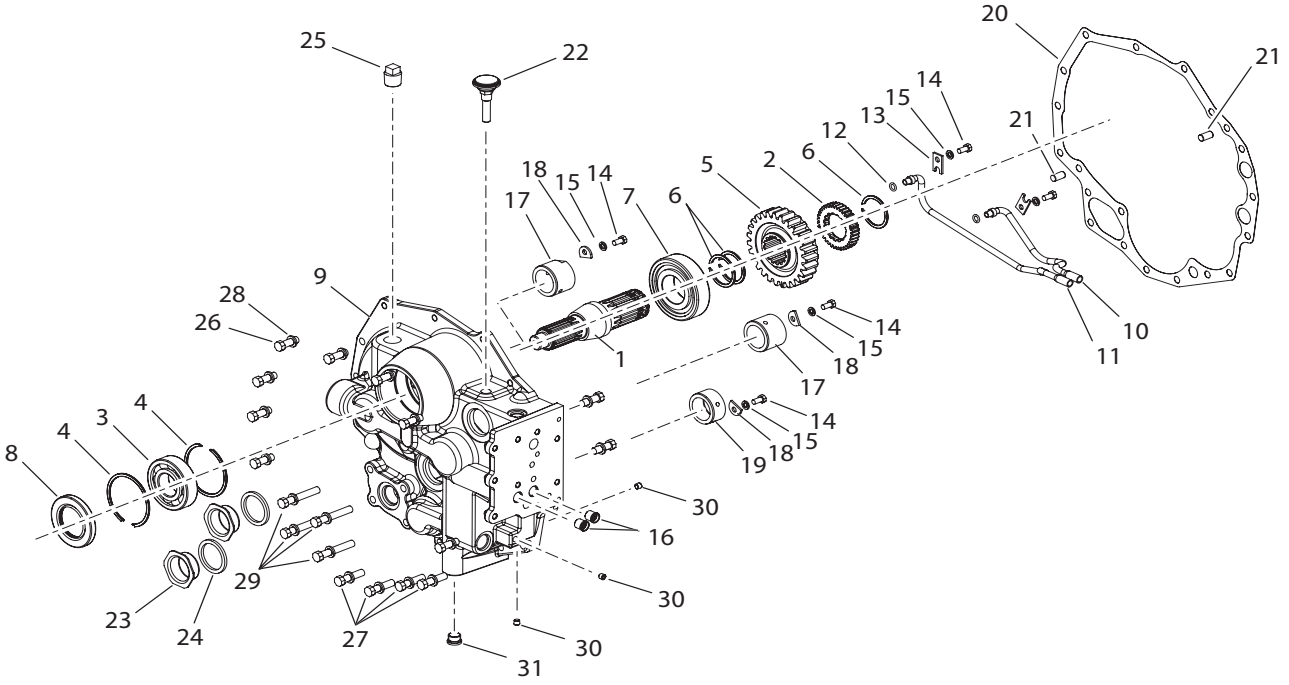
The supply current cannot exceed 10mA otherwise the sensor will be damaged.
Be sure the supply voltage does not exceed 5Vdc

Connect the sensor to an external power supply of 5V DC.
Measure the DC voltage between the output andground.
In normal atmospheric circumstances (1 bar) the voltage should be ±0.25Vdc (5% of supplied 5Vdc).



TE15

GROUP-INPUT SHAFT AND FRONT COVER



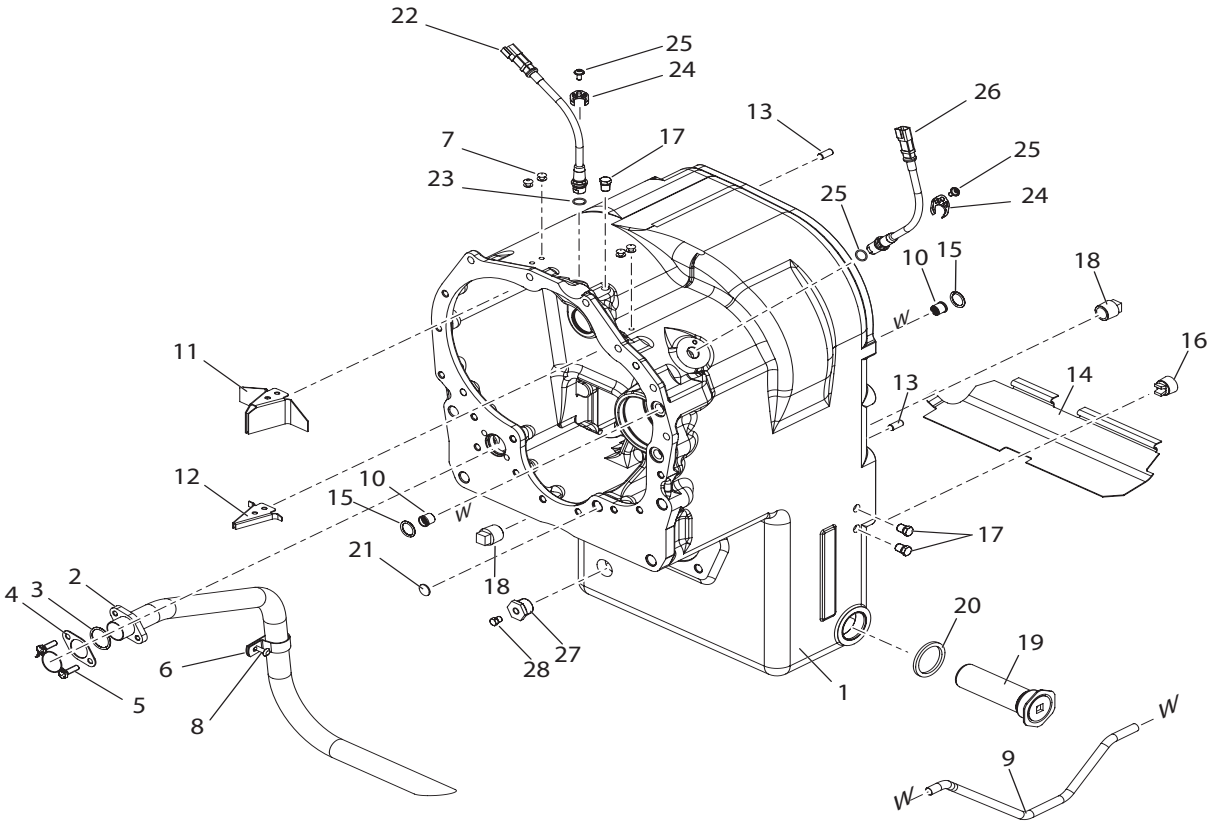
GRPTE15011rev FEB06

INPUT SHAFT & FRONT COVER GROUP

Item	Description	Qty
1	Shaft - input	1
2	Exciter ring - Turbine shaft	1
3	Bearing	1
4	Ring - Input shaft front bearing retaining	2
5	Gear - Input shaft	1
6	Snap ring - Gear	3
7	Bearing - Input shaft rear	1
8	Seal - Input flange oil	1
9	Assy - Front cover & tube	1
10	Assy - Reverse speed tube	1
11	Assy - 3rd speed tube	1
12	O ring	2
13	Tube clip	2
14	Capscrew	5
15	Lockwasher	5
16	Sleeve - press & lube tube	2
17	Sleeve - Converter housing	2
18	Washer	3
19	Race - Piston ring	1
20	Gasket - Front cover	1
21	Pin - Front cover dowel	2
22	Breather - Air	1
23	Plug - Front cover	2
24	Gasket	2
25	Plug - Pipe	1
26	Screw - Front cover to transmission case	10
27	Screw - Front cover to transmission case	4
28	Lockwasher - Front cover to transmission case	18
29	Screw - Front cover to transmission case	4
30	Plug - Pipe	3
31	Plug - Lube system	1

TE15

GROUP-TRANSMISSION CASE

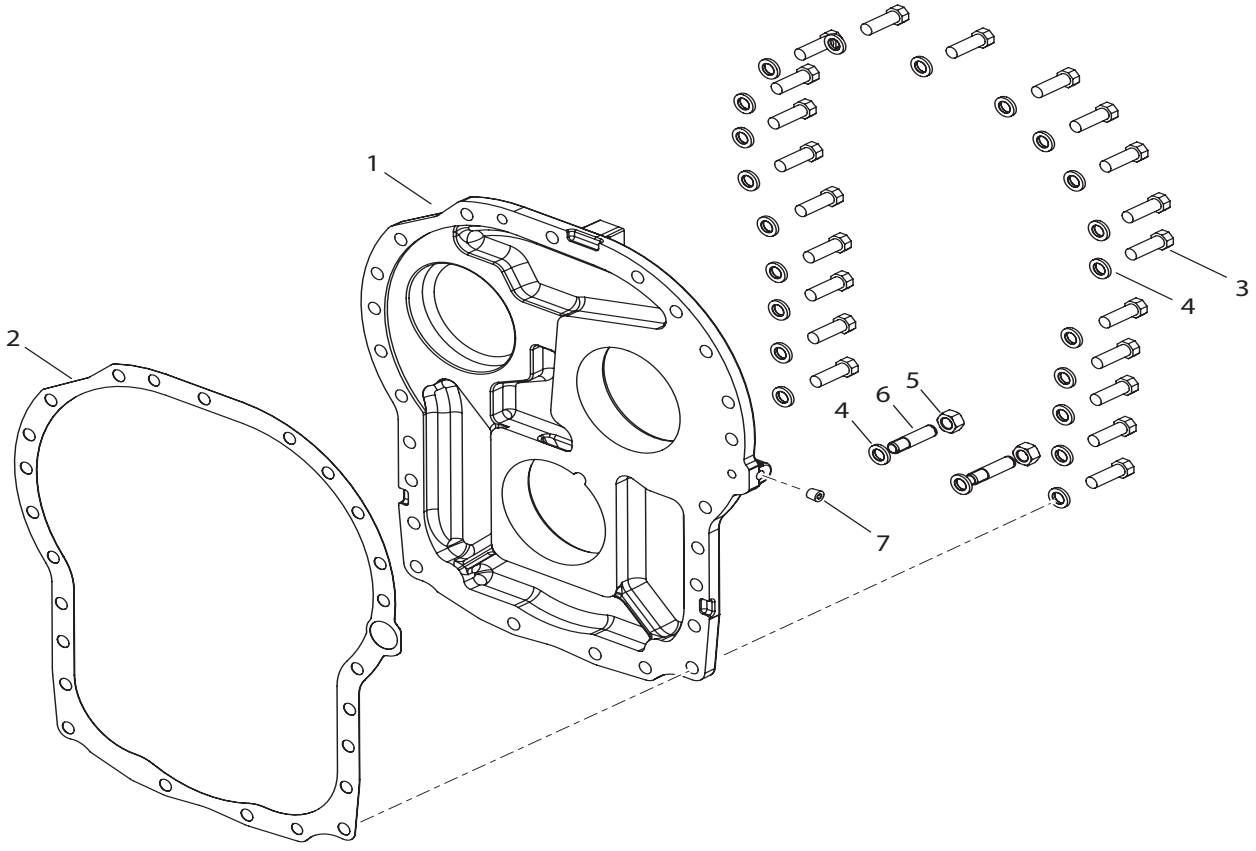


GRPTE15021 rev FEB06

TRANSMISSION CASE GROUP

Item	Description	Qty
1	Assy - Transmission case & tube	1
2	Assy - Transmission suction tube	1
3	O ring	1
4	Plate - Suction tube retaining	1
5	Capscrew	2
6	Clip - Suction tube	1
7	Rivet	4
8	Rivet	1
9	Tube - Low clutch pressure	1
10	Sleeve - Pressure & lubrication tube	2
11	Baffle - Oil	1
12	Baffle - Oil	1
13	Pin - Transmission case to rear cover dowel	2
14	Baffle - Oil	1
15	O ring - Clutch pressure tube	2
16	Plug - Magnetic drain	1
17	Plug - Oil level & lockup port	3
18	Plug	1
19	Assy - Suction screen	1
20	GAsket - Suction screen	1
21	Plug - 4th lube	1
22	Assy - Speed sensor	1
23	O ring - Speed sensor	1
24	Support - Speed sensor	1
25	Capscrew - Speed sensor	1
26	Assy - Speed sensor	1
27	Bushing - Reducing pipe	1
28	Plug - Pipe	2

TE15
GROUP-REAR COVER

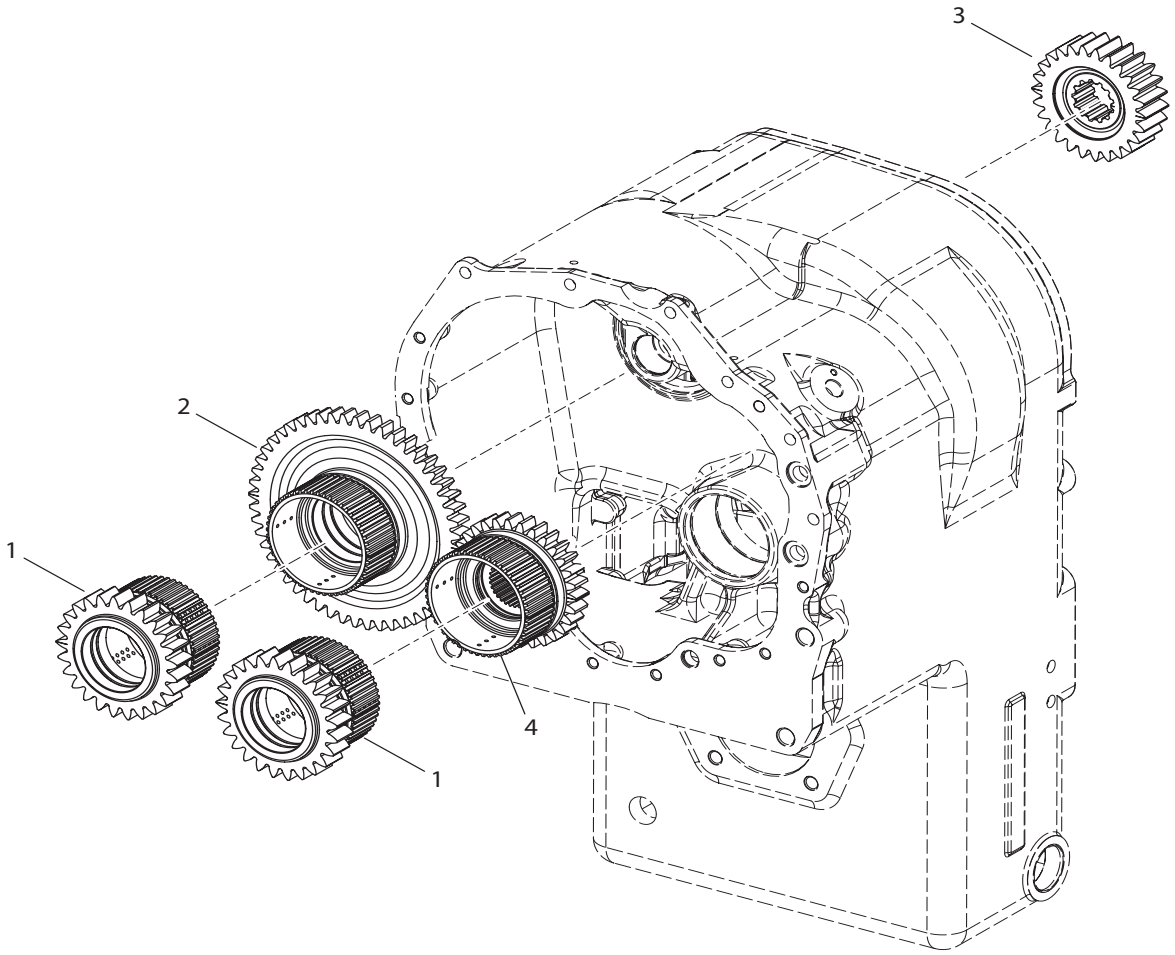


GRPTE15031 rev FEB06

REAR COVER GROUP

Item	Description	Qty
1	Cover - Rear	1
2	Gasket - Rear cover to transmission case	1
3	Capscrew	21
4	Lockwasher - Mounting screw	23
5	Nut	2
6	Stud	2
7	Plug	1

TE15
GROUP-FWD AND REV SHAFT



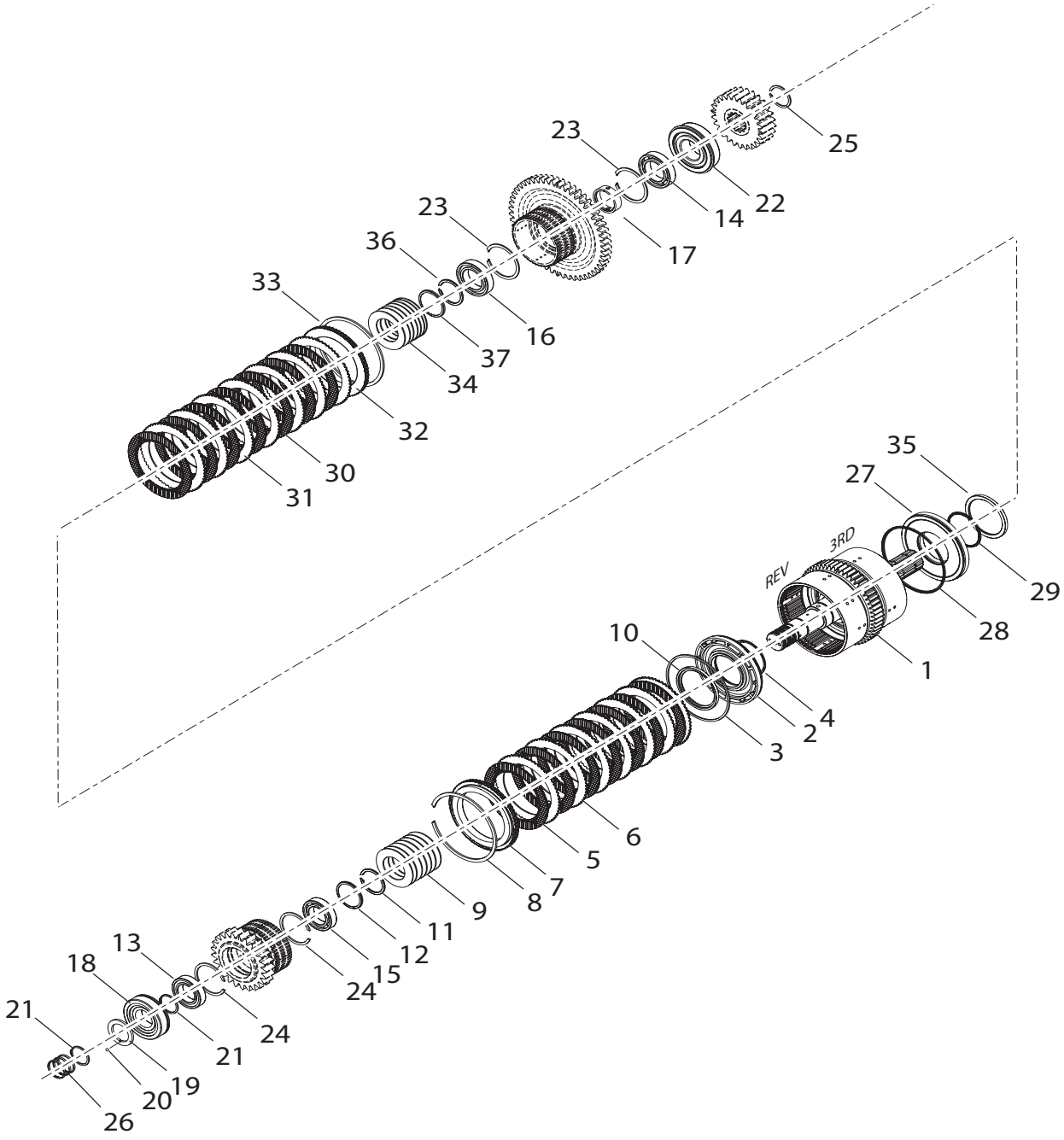
GRPTE15041 rev FEB06

FWD & REV SHAFT GROUP

Item	Description	Qty
1	Gear - Clutch hub	2
2	High - range gear & clutch hub	1
3	Gera - Drive low & 4th	1
4	Gera - Clutch hub	1

TE15

GROUP-REV AND 3RD CLUTCH SHAFT



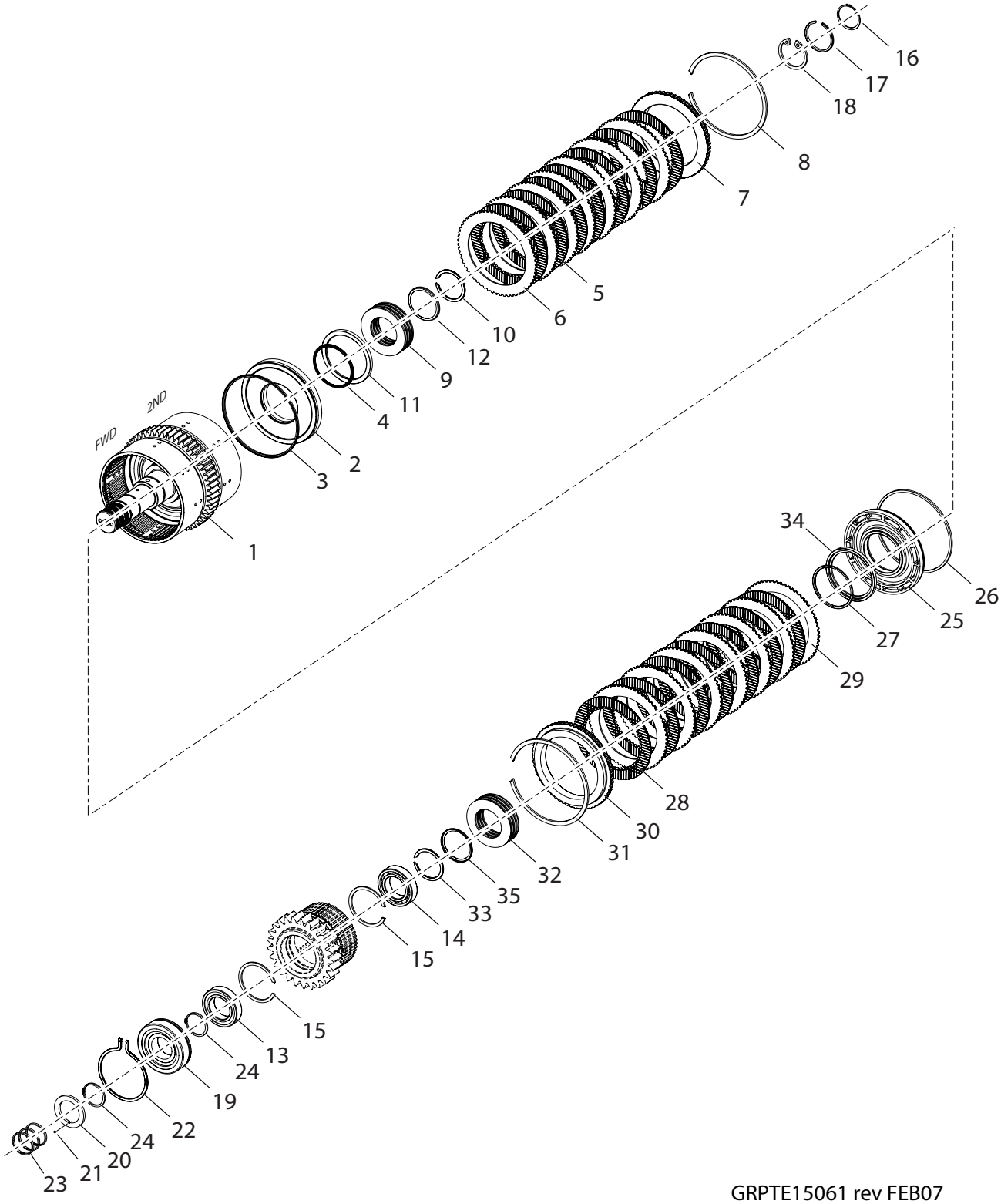
GRPTE15051 rev FEB06

REV & 3rd CLUTCH SHAFT GROUP

Item	Description	Qty
1	Assy - Reverse & 3rd shaft	1
2	Assy - Clutch piston	1
3	Seal - Outer clutch piston	1
4	Seal - Inner clutch piston	1
5	Disc - Clutch inner	7
6	Disc - Clutch outer	7
7	Plate - Clutch end	1
8	Snap ring - Clutch end plate	1
9	Assy - Disc spring	7
10	Spacer - Piston	1
11	Snap ring - Spring retaining	1
12	Retainer - Snap ring	1
13	Ball -Bearing	1
14	Bearing - High gear	1
15	Bearing - Clutch driven gear	1
16	Bearing - High gear	1
17	Spacer - High gear bearing	1
18	Bearing - Clutch shaft	1
19	Plate - Rev & high shaft front bearing	1
20	Ball - Rev & high shaft front bearing end plate retaining	1
21	Ring - Front bearing retaining	2
22	Bearing - Rev & high shaft rear	1
23	Snap ring - High gear bearing	2
24	Snap ring - Clutch driven gear bearing	2
25	Ring - Gear retaining	1
26	Ring - Sealing	3
27	Assy - Clutch piston	1
28	Seal - Outer clutch piston	1
29	Seal - Inner clutch piston	1
30	Disc - Clutch inner	7
31	Disc - Clutch outer	7
32	Plate - Clutch end	1
33	Snap ring - Clutch end plate	2
34	Assy - Disc spring	7
35	Spacer - Piston	1
36	Snap ring - Spring retaining	1
37	Retainer - Snap ring	1

TE15

GROUP-FWD AND 2ND CLUTCH SHAFT

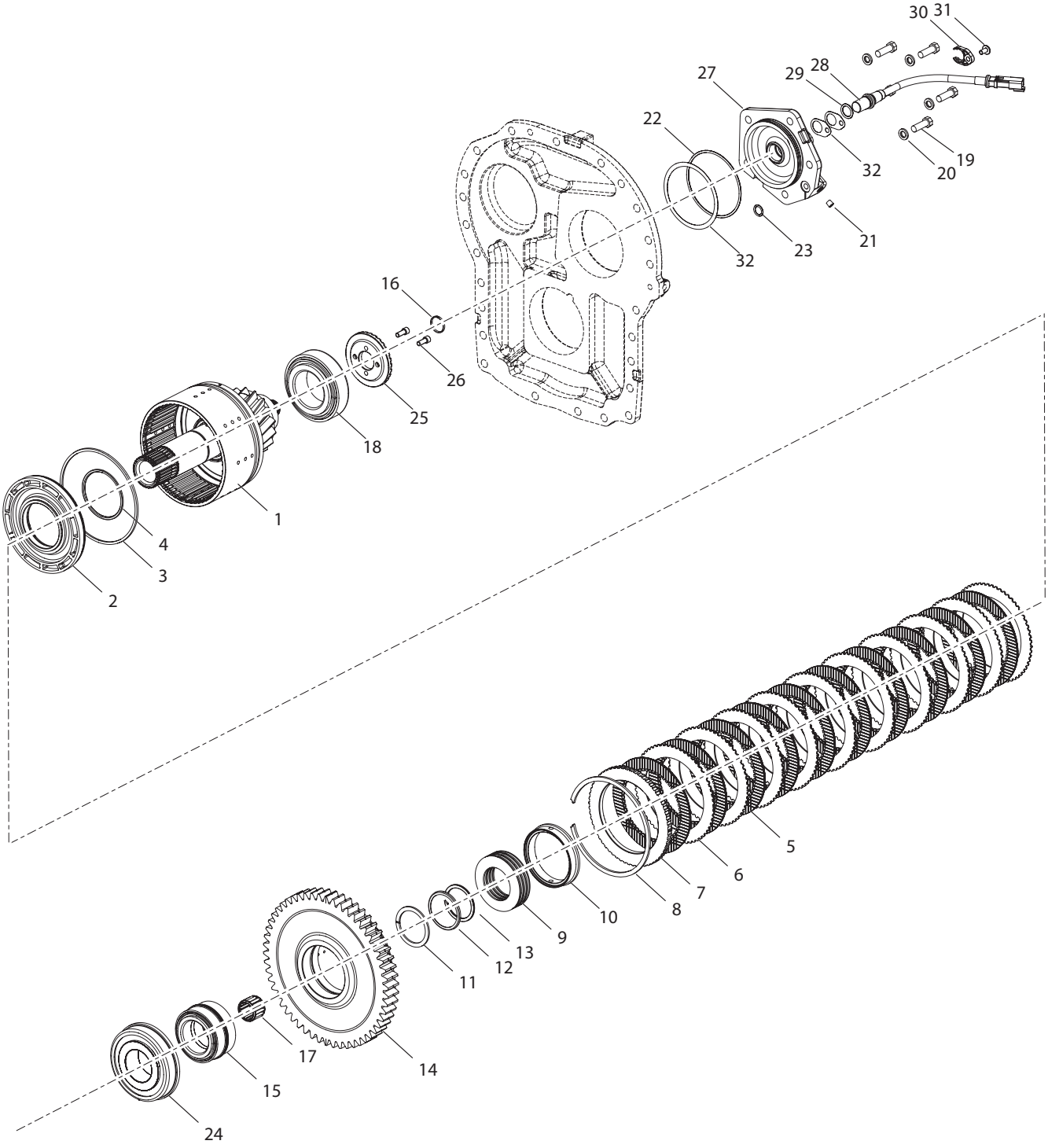


GRPTE15061 rev FEB07

FWD & 2nd CLUTCH SHAFT GROUP

Item	Description	Qty
1	Assy - Fwd & 2nd shaft	1
2	Assy - Clutch piston	1
3	Seal - Outer clutch piston	1
4	Seal - Inner piston	1
5	Disc - Inner	7
6	Disc - Outer	7
7	Plate - Clutch end	1
8	Snap ring -Clutch end plate	1
9	Assy - Disc spring	7
10	Snap ring - Spring retaining	1
11	Spacer - Piston	1
12	Retainer - Snap ring	1
13	Bearing - Clutch driven gear	1
14	Bearing - Clutch driven gear	1
15	Snap ring - Clutch driven gear bearing	2
16	Snapr ring - 2nd gear locating	1
17	Retainer - 2nd gear locating ring	1
18	Snap ring - 2nd gear locating ring	1
19	Bearing - Fwd & 2nd shaft front	1
20	Plate - Fwd & 2nd shaft front bearing end	1
21	Ball - Fwd & 2nd shaft front bearing end plate retaining	1
22	Ring - Front bearing locating ring	1
23	ring - Sealing	3
24	Ring - Front bearing retaining	2
25	Assy - Clutch piston	1
26	Seal - Outer clutch piston	1
27	Seal - Inner clutch piston	1
28	Disc - Clutch inner	7
29	Disc - Clutch outer	7
30	PLate - Clutch end	1
31	Snap ring - Clutch end plate	1
32	Assy - Disc spring	7
33	Snap ring - Spring retaining	1
34	Spacer - Piston	2
35	Retainer - Snap ring	2

TE15
GROUP-LOW SHAFT



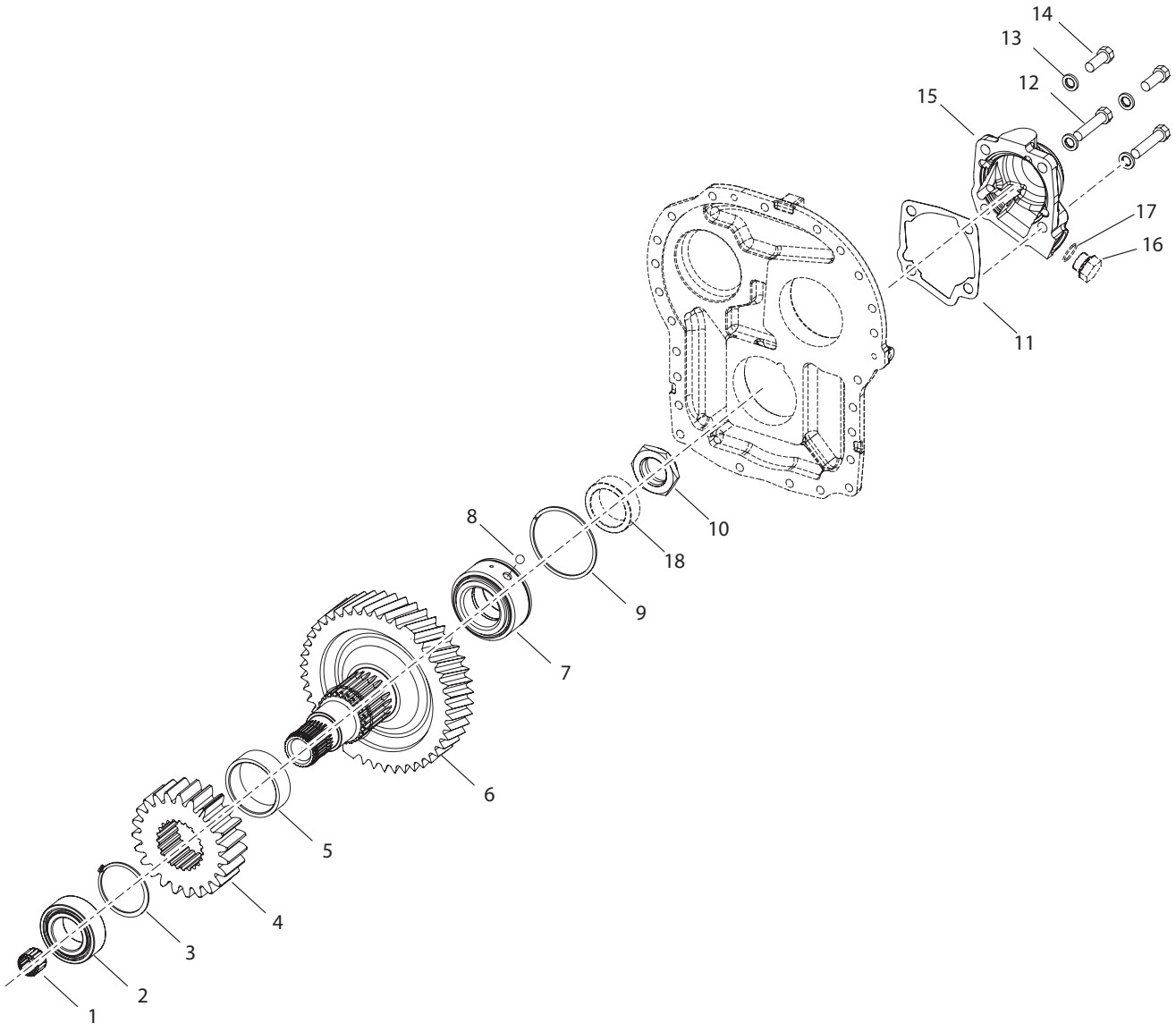
GRPTE15071 rev FEB06

LOW SHAFT GROUP

Item	Description	Qty
1	Assy - Low shaft	1
2	Assy - Clutch piston	1
3	Seal - Outer clutch piston	1
4	Seal - Inner clutch piston	1
5	Disc - Clutch inner	10
6	Disc - Clutch outer	10
7	Plate - Clutch end	1
8	Ring - End plate retaining	1
9	Assy - Spring disc	7
10	Spacer - Piston	1
11	Washer - bearing	1
12	Snap ring	1
13	Retainer - Spring retaining ring	1
14	Gear - Low clutch	1
15	Assy - Low spead gear bearing	1
16	Ring - Clutch shaft sealing	1
17	Bearing - Low speed clutch shaft pilot	1
18	Bearing - Low speed shaft rear	1
19	Screw - Bearing cap	5
20	Lockwasher - Bearing cap screw	5
21	Plug - Rear bearing cap	1
22	O ring -Rear bearing cap	1
23	O ring - Rear bearing cap	1
24	Bearing	1
25	Ring - Exciter low shaft	1
26	Capscrew	2
27	Cap - Low shaft bearing	1
28	Assy - Speed sensor	1
29	O ring - Speed sensor	1
30	Support - Speed sensor	1
31	Capscrew - Speed sensor	1
32	Shim - adjustment	2
33A	Shim - Bearing cao .004	AR
33B	Shim - Bearing cap .007	AR
33C	Shim - Bearing cap .010	AR
33D	Shim - Bearing cap .020	AR

AR = As required

TE15
GROUP-IDLER SHAFT



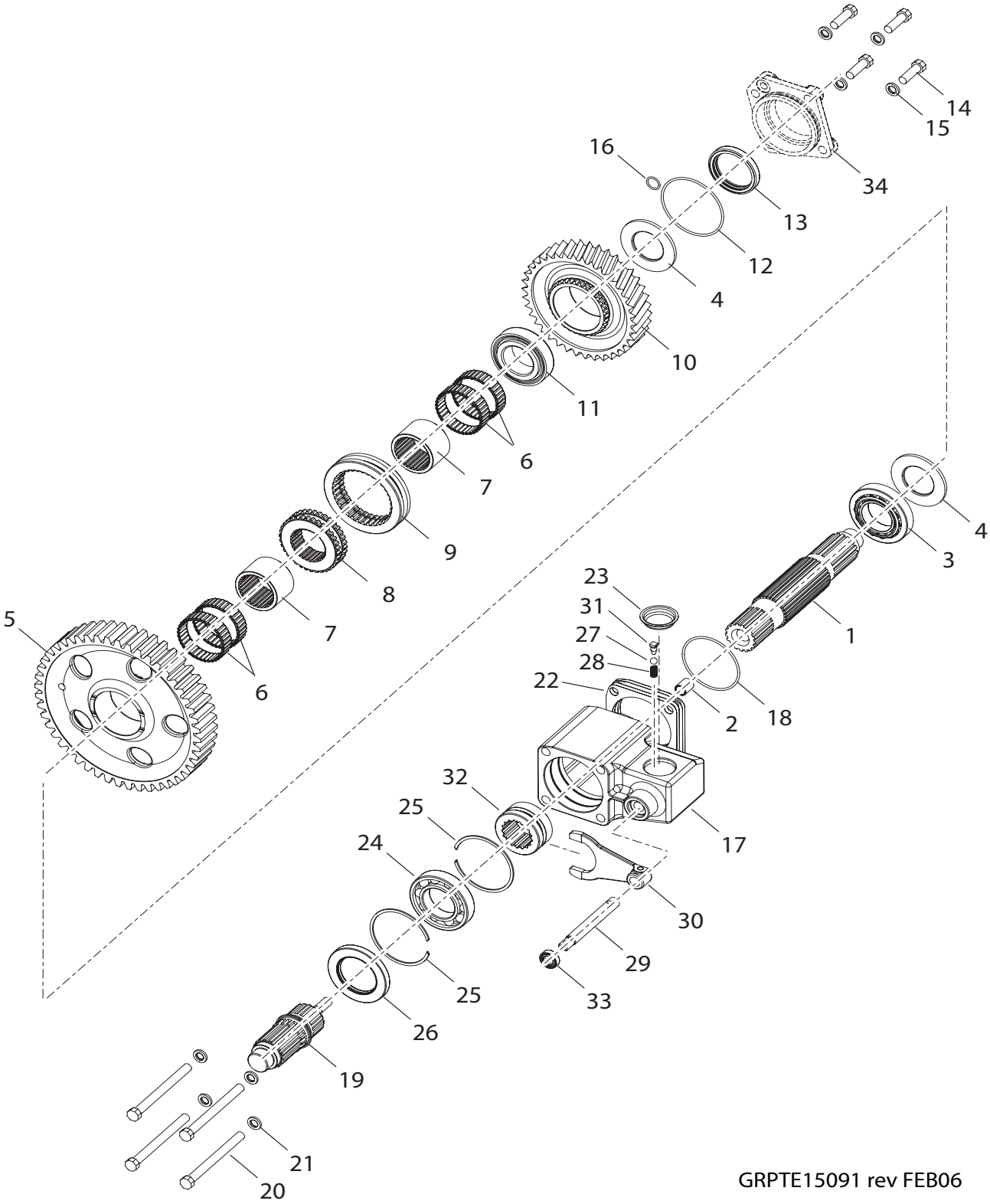
GRPTE15081rev FEB06

IDLER SHAFT GROUP

Item	Description	Qty
1	Bearing	1
2	Bearing	1
3	Snap ring	1
4	Gear - Idler shaft	1
5	Spacer - Idler	1
6	Gear & idler shaft	1
7	Bearing	1
8	Ball - Bearing locating	1
9	Snap ring	1
10	Nut -Lock	1
11	Gasket - Bearing cap	1
12	Capscrew	2
13	Lockwasher	4
14	Capscrew	2
15	Cap - Rear bearing	1
16	Cap plug - Idler shaft	1
17	O ring	1
18	Spacer - Rear bearing cap	1

TE15

GROUP-OUTPUT SHAFT WITH FRONT DISCONNECT

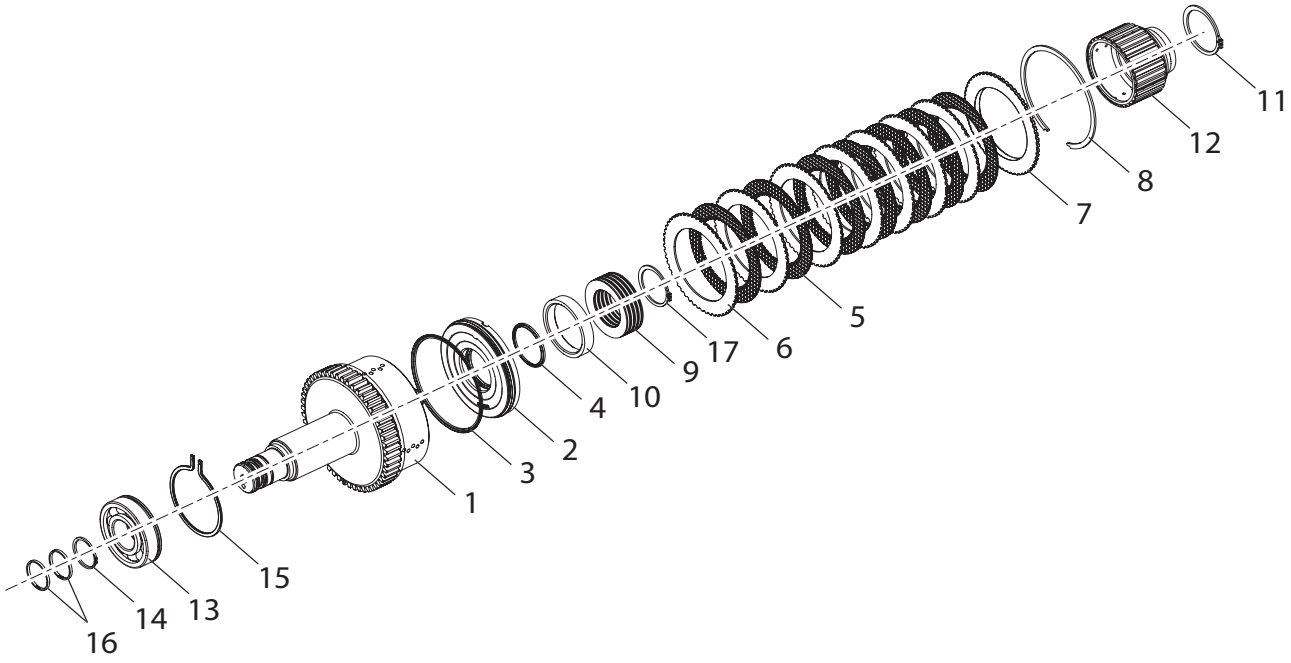


GRPTE15091 rev FEB06

OUTPUT SHAFT WITH FRONT DISCONNECT GROUP

Item	Description	Qty
1	Assy - Output shaft & bushing	1
2	Output shaft bushing	1
3	Bearing	1
4	Washer - Thrust	2
5	Gear - low range	1
6	Caged roller assy	4
7	Inner race	1
8	Sleeve - Shift hub	1
9	Hub - Shift	1
10	Gear - Output shaft	1
11	Bearing	1
12	O ring	1
13	Seal - Oil	1
14	Capscrew	4
15	Lockwasher	4
16	O ring	1
17	Housing - Disconnect	1
18	O ring	1
19	Shaft - Disconnect	1
20	Capscrew	4
21	Lockwasher	4
22	Shim	AR
23	Plug	1
24	Bearing	1
25	Snap ring	2
26	Seal - Oil	1
27	Ball	1
28	Spring - Detent	1
29	Rail - Shigt	1
30	Fork - Disconnect shift	1
31	Lockwasher - Shift fork	1
32	Hub - Shift	1
33	Seal - Oil	1
34	Cap - Output shaft	1

TE15
GROUP-4TH CLUTCH SHAFT



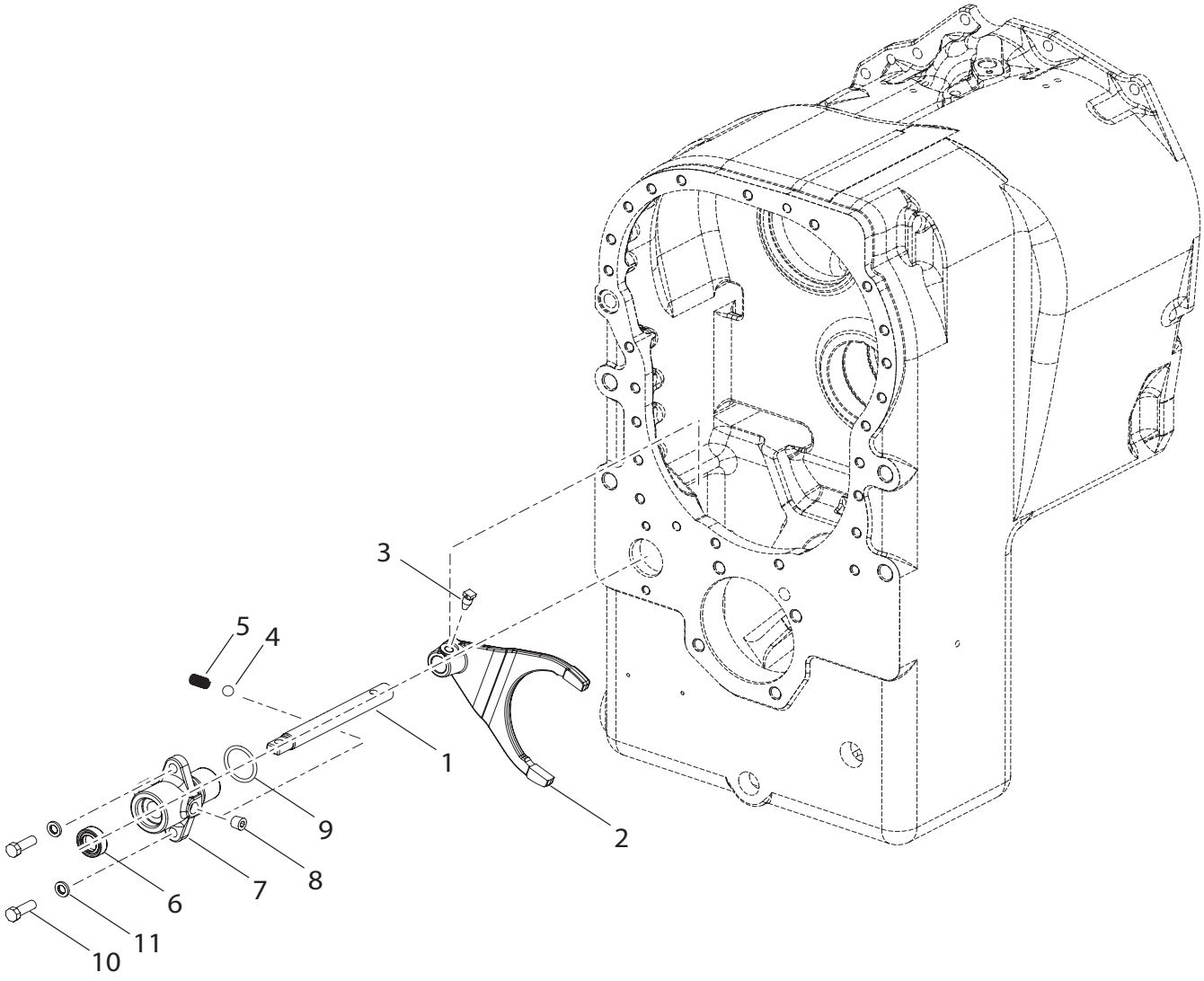
GRPTE15101 rev JAN06

4th CLUTCH SHAFT GROUP

Item	Description	Qty
1	Assy - 4th clutch shaft	1
2	Assy - Clutch piston	1
3	Seal - Outer clutch piston	1
4	Seal - Inner clutch pisotn	1
5	Disc inner	7
6	Disc - Outer	7
7	Plate - Clutch end	1
8	Snap ring - Clutch end plate	1
9	Assy - Disc spring	9
10	Spacer	1
11	Snap ring - Clutch hub	1
12	Hub - Clutch	1
13	Bearing	1
14	Ring - Front bearing retaining	1
15	Snap ring - Front bearing	1
16	Ring - Piston	2
17	Snap ring - Spring retainer	1

TE15

GROUP-HIGH & LOW RANGE SHIFT CONTROL



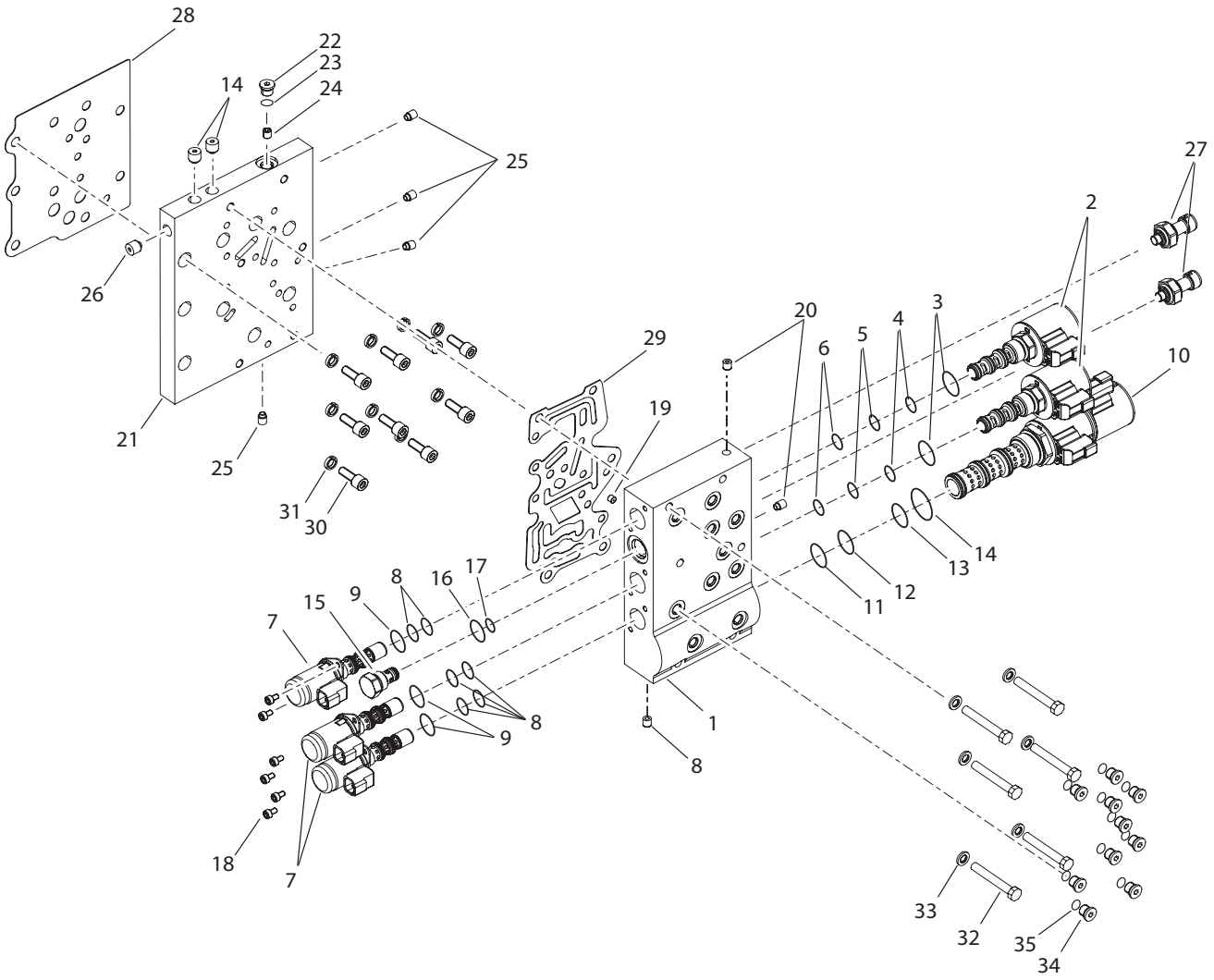
GRPTE15111 rev FEB06

HIGH & LOW RANGE SHIFT CONTROL GROUP

Item	Description	Qty
1	Rail - Range shift	1
2	Fork - Shift	1
3	Lockscrew - Shift fork	1
1	Ball	1
5	Spring - Detent	1
6	Seal - Oil	1
7	Housing - Disconnect shift	1
8	Plug	1
9	O ring	1
10	Capscrew	2
11	Lockwasher	2

TE15

GROUP-ELECTRIC CONTROL VALVE

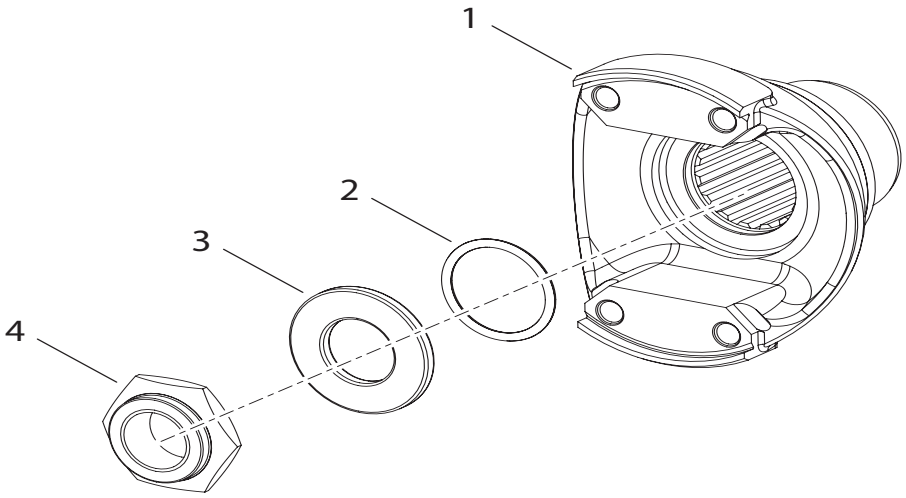


GRPTE15121 rev JAN06

ELECTRIC CONTROL VALVE GROUP

Item	Description	Qty
1	Assy - Control valve	1
2	Assy - Solenoid	2
3	O ring	2
4	O ring	2
5	O ring	2
6	O ring	2
7	Assy - Solenoid	3
8	O ring	6
9	O ring	3
10	Assy - Solenoid	1
11	O ring	1
12	O ring	1
13	O ring	1
14	O ring	1
15	Plug	1
16	O ring	1
17	O ring	1
18	Screw	16
19	Plug - Orifice	1
20	Plug - Expansion	3
21	Assy - Valve adaptor	1
22	Plug	1
23	O ring	1
24	Plug - Orifice	1
25	Plug - Expansion	4
26	Plug - Expansion	3
27	Sensor - Valve pressure	2
28	Gasket - Adaptor assy to converter housing	1
29	Gasket - Control valve	1
30	Capscrew	9
31	Lockwasher	9
32	Capscrew	6
33	Lockwasher	6
34	Plug - Fitting	10
35	O ring	10

TE15
GROUP-FLANGE

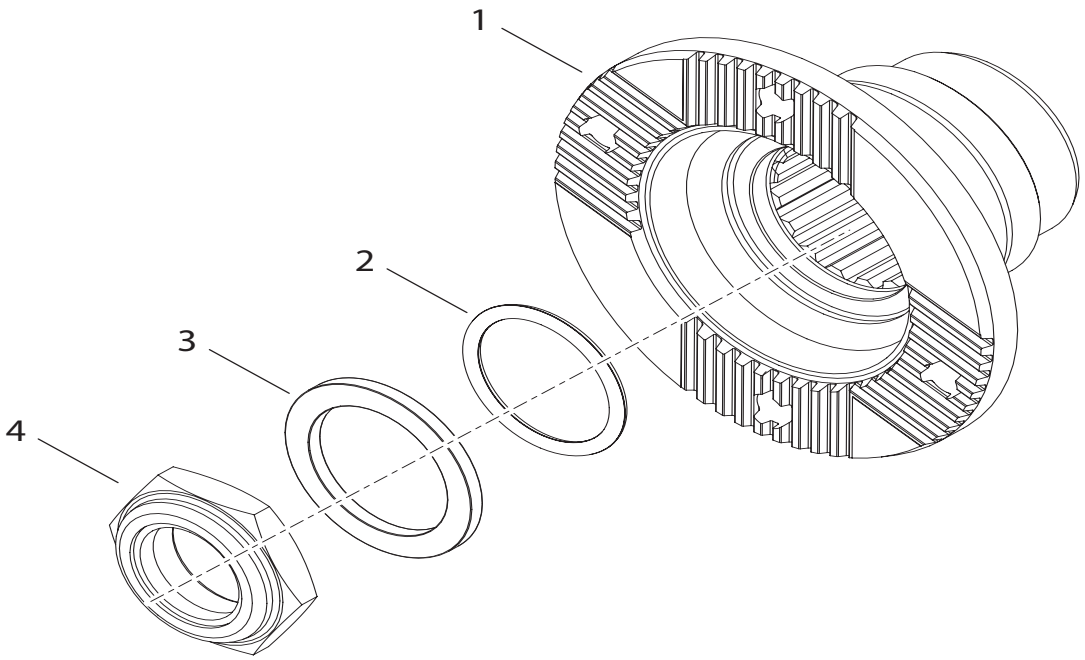


GRPTE15131 rev FEB06

INPUT FANGE GROUP

Item	Description	Qty
1	Fange	1
2	O ring	1
3	Washer - Flange	1
4	Nut - Lock	1

TE15
GROUP-FLANGE



GRPTE15141 rev FEB06

OUTPUT FANGE GROUP

Item	Description	Qty
1	Fange	2
2	O ring	2
3	Washer - Flange	2
4	Nut - Lock	2

9. TE15 ASSEMBLY INSTRUCTIONS

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Figure 1
Front view of the TE15 8 speed transmission.

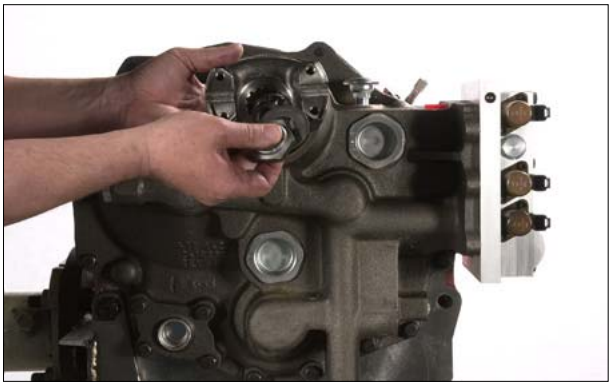

Figure 2
Remove input flange nut, washer & o-ring.

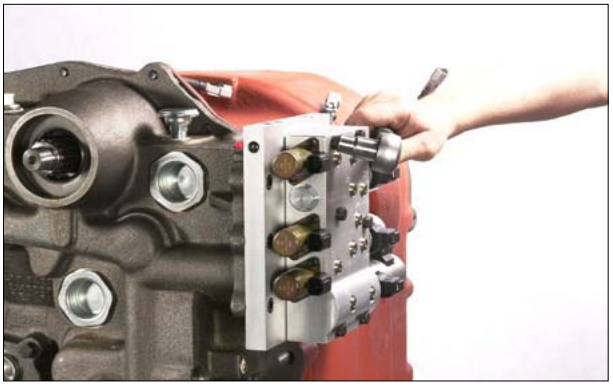

Figure 3
Remove 2 valve to transmission housing cap screws.
Install aligning studs and remove remaining screws.

Figure 4
Remove valve assy and valve gasket.

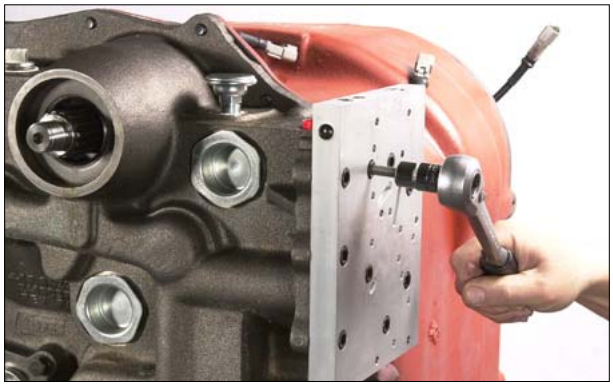

Figure 5
Remove plate screws and valve plate.

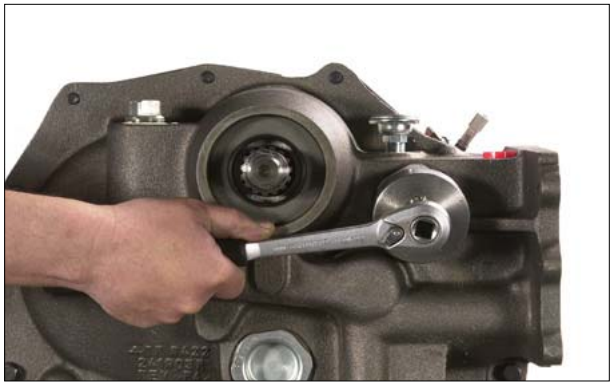

Figure 6
Remove 2 front cover plugs.

Figure 7
Remove 2 front cover to transmission case screws and install aligning studs. Remove remainder of the screws.

Figure 8
Use a hoist to secure the front cover and pry the cover from the transmission case whilst holding the 2nd & 4th clutch front bearing retaining snap rings open in turn.

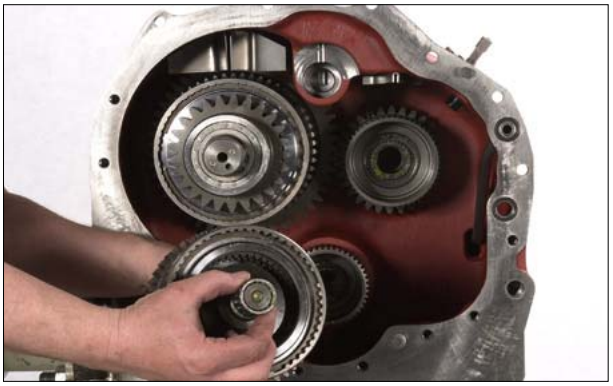

Figure 9
Remove 4th gear clutch drum and pilot bearing.

Figure 10
Remove speed sensor and screw (3)

Figure 11
Remove low shaft bearing cap screws. Carefully pry bearing cap from rear cover and remove shims.

Figure 12
Remove idler shaft bearing cap screws and remove idler shaft bearing cap and gasket.

Figure 13
Remove rear cover to transmission case screws.

Figure 14
Remove idler shaft rear bearing retaining snap ring.

Figure 15 Install 2 aligning studs. By means of a special too (See Special Tools Section) remove rear cover.

Figure 16
Remove gasket.

Figure 17
Remove ball

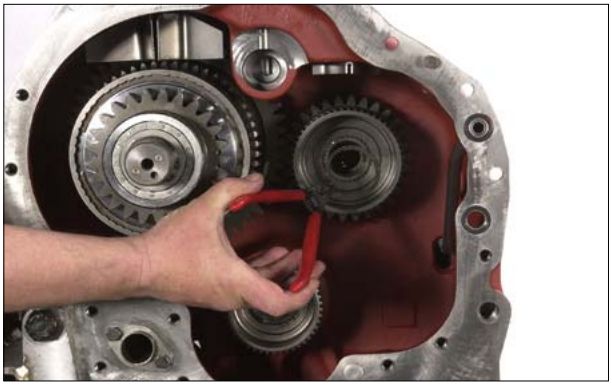

Figure 18
From the front remove 2nd clutch hub retaining snap ring

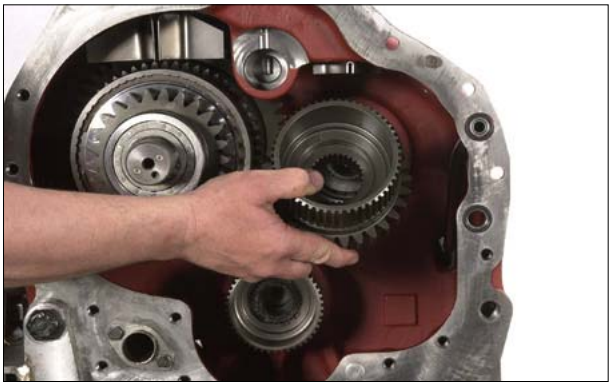

Figure 19
Remove 2nd clutch hub

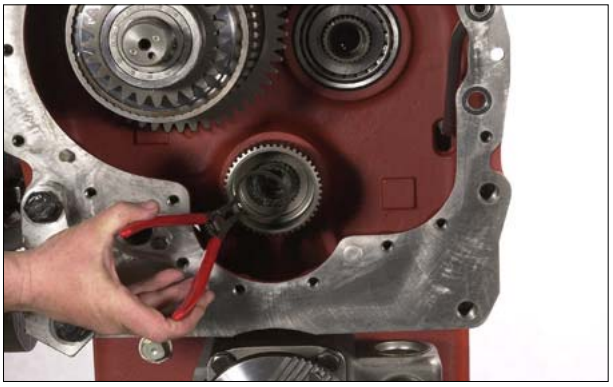

Figure 20
Remove 4th clutch hub retaining snap ring.

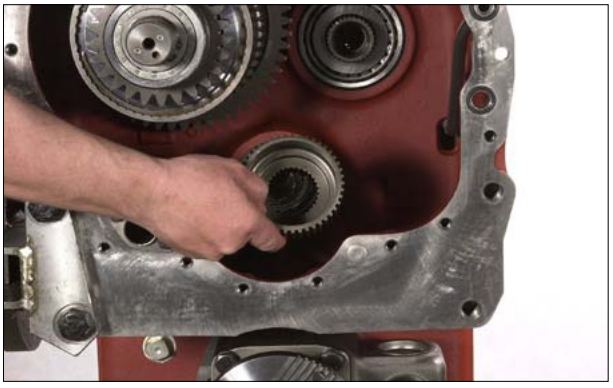

Figure 21
Remove 4th clutch hub.

Figure 22
Remove idler shaft nut and install hook. Gently tap low clutch loose and install hook on idler shaft. Use a hoist to lift idler shaft, whilst gently pushing low clutch shaft aside.

Figure 23
Remove low clutch shaft assy.

Figure 24
Remove low & 4th drive gear retaining ring.

Figure 25
Remove low & 4th drive gear.

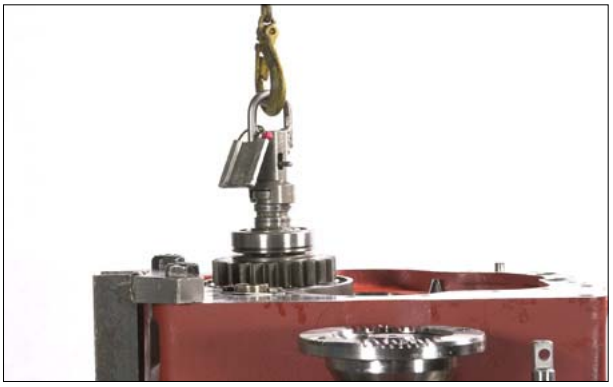

Figure 26
Remove Rev & 3rd clutch drum assy from transmission case.

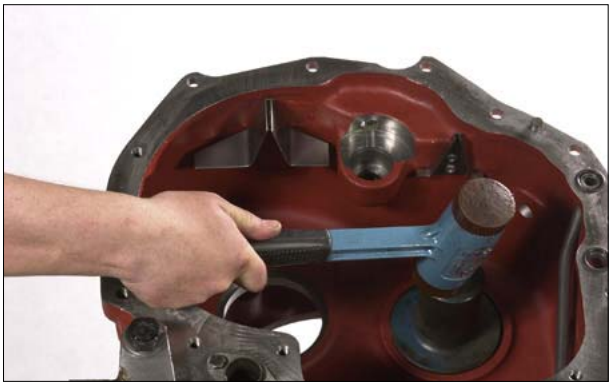

Figure 27
Using a special tool tap bearing cup from transmission case

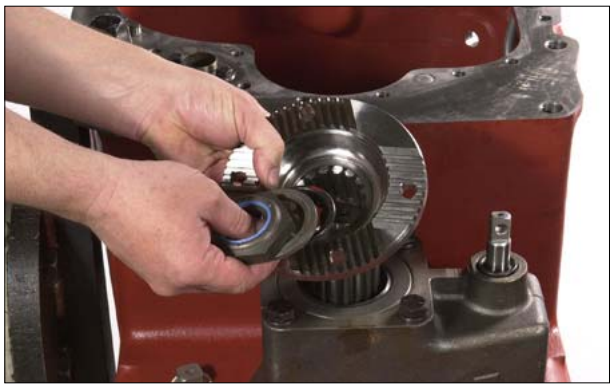

Figure 28
Remove front output flange, nut, washer & o-ring

Figure 29
Remove rear output flange, nut, washer & o-ring

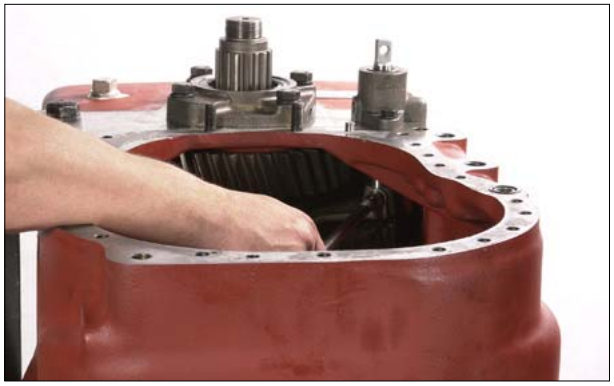

Figure 30
Remove High-Low range shift fork lock screw

Figure 31
Remove High-Low range shift fork cap screws and remove High-Low range shift fork assy

Figure 32
Remove disconnect housing cap screws and remove disconnect assy and shims

Figure 33
Remove rear output cap screws and remove rear output cap

Figure 34
Using a special tool push output shaft from transmission case

Figure 35
From the front remove output shaft assy

Figure 36
Remove caged roller assy

Figure 37
Remove trust washer and bearing cone

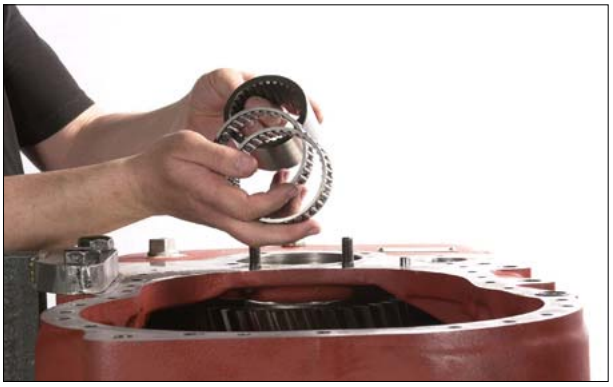

Figure 38
Remove caged roller bearing assy

Figure 39
Remove High gear

Figure 40
Remove shift hub sleeve

Figure 41
Remove Low gear

Figure 42
Remove oil baffle

Figure 43
Remove suction tube cap screws, tube and o-ring

Figure 44
Open FWD/2nd front bearing snap ring and pry drum from front cover

Figure 45
Tap on input shaft with a soft hammer to remove input shaft

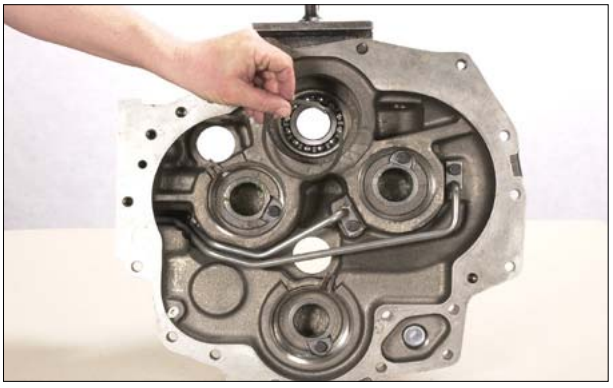

Figure 46
Remove input shaft front bearing retaining ring

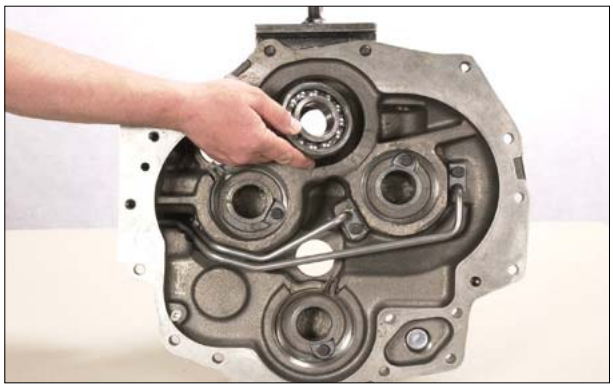

Figure 47
Remove input shaft front bearing

Figure 48
If needed using a puller remove front cover sleeve (3)

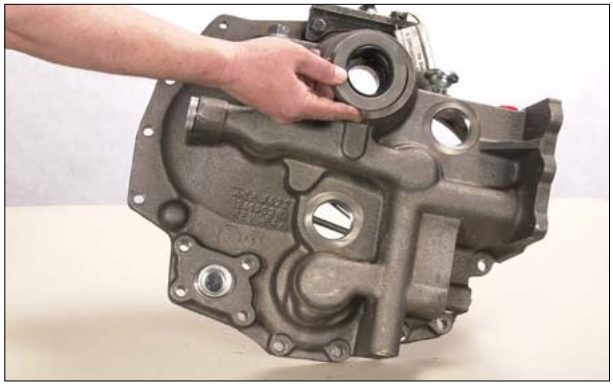

Figure 49
Remove input flange oil seal

Figure 50
If needed install front cover sleeves (3) and torque as specified.

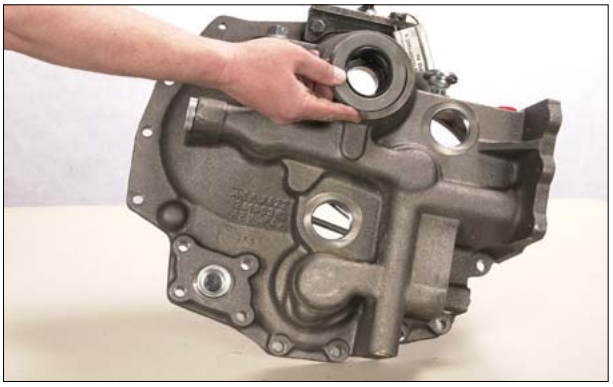

Figure 51
Install input flange oil seal

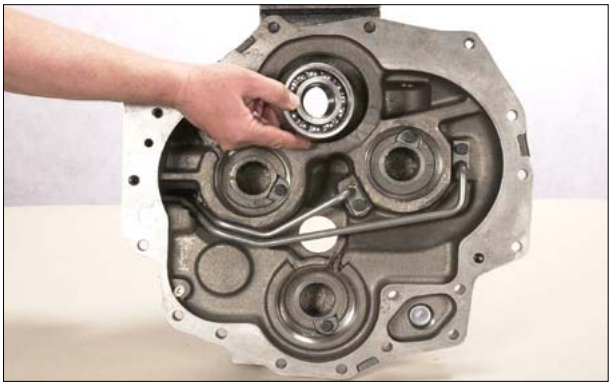

Figure 52
Install input shaft front bearing

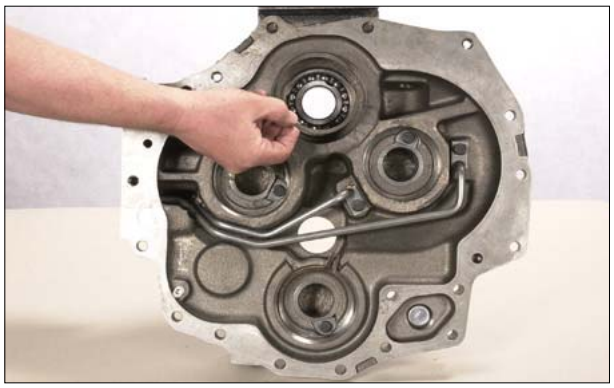

Figure 53
Install input shaft front bearing retaining ring

Figure 54
Remove gear retaining ring

Figure 55
Remove input shaft sensor gear

Figure 56
Remove input shaft sensor gear locating snap ring

Figure 57
Remove input shaft bearing retaining snap ring

Figure 58
Remove input gear

Figure 59
By means of a puller remove bearing

Figure 60
Warm bearing to 120°C [248°F] and install bearing

Figure 61
Install input gear

Figure 62
Install input gear retaining snap ring

Figure 63
Install input shaft sensor gear locating snap ring

Figure 64
Install input shaft sensor gear

Figure 65
Install input shaft sensor gear snap ring

Figure 66
Remove low clutch shaft sealing ring

Figure 67
Remove low shaft rear bearing cup

Figure 68
Remove low shaft clutch assy sensor gear screws

Figure 69
Remove low shaft clutch assy sensor gear

Figure 70
Using a puller remove low shaft clutch assy rear bearing cone

Figure 71
Turn assy and using a puller remove low shaft clutch assy front bearing cone

Figure 72
Using a puller remove high range gear, hub and bearing

Figure 73
Remove bearing washer

Figure 74
Remove backing ring retaining snap ring

Figure 75
Remove backing ring

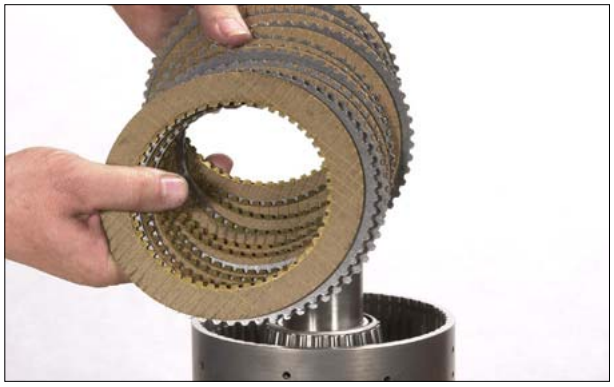

Figure 76
Remove inner and outer discs

Figure 77
Remove low clutch gear hub inner bearing cone

Figure 78
Remove bearing washer

Figure 79
Remove spring retaining snap ring retainer

Figure 80
Remove snap ring

Figure 81
Remove piston return spring discs

Figure 82
Remove piston spacer

Figure 83
Remove piston

Figure 84
Remove drum retaining ring

Figure 85
Tap gently on shaft to separate drum from shaft

Figure 86
Remove o-ring

Figure 87
Install o-ring

Figure 88
Install drum on shaft

Figure 89
Install drum retaining ring

Figure 90
Refer to “Cleaning and Inspection “ pages. Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.
Install piston in clutch drum. Use caution as not to damage newly installed seal rings.

Figure 91
Install spacer

Figure 92
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

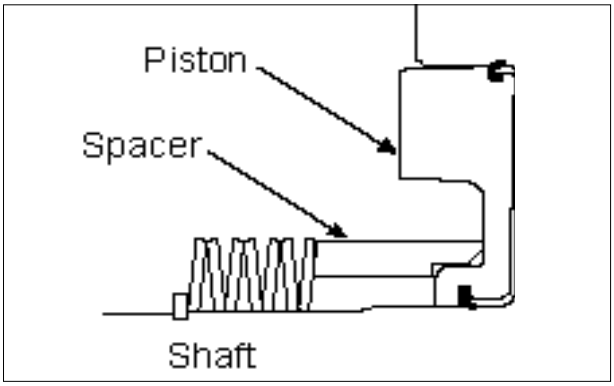

Figure 93
Drawing

Figure 94
Compress spring discs and install spring disc retaining snap ring

Figure 95
Install snap ring retainer ring (See drawing for correct installation

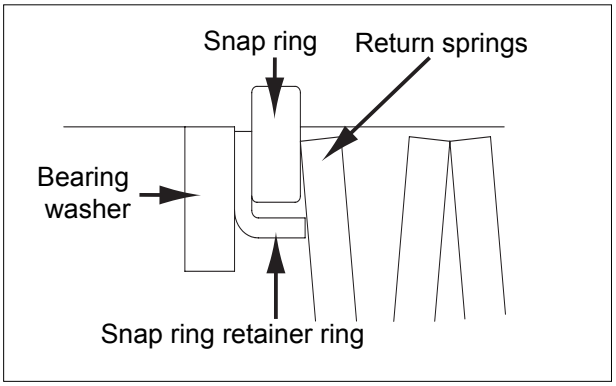

Figure 96
Drawing

Figure 97
Install bearing washer

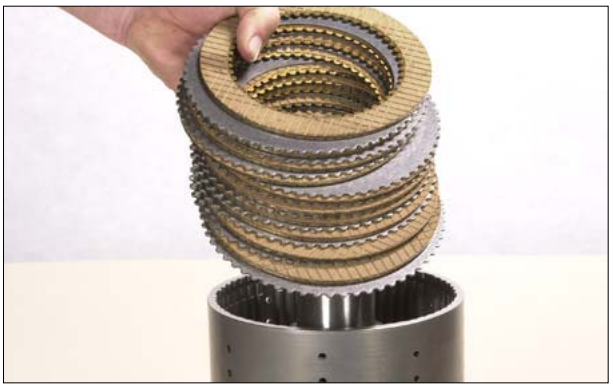

Figure 98
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

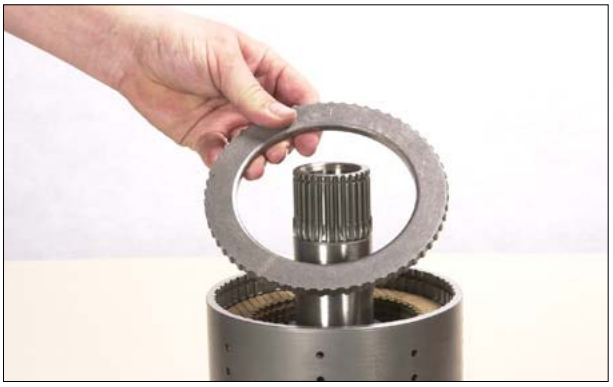

Figure 99
Install end plate.

Figure 100
Install end plate retaining snap ring

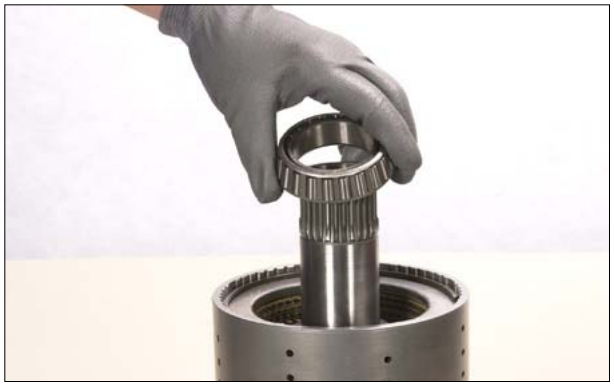

Figure 101
Warm bearing cone to 120° C [248° F] and install on clutch shaft

Figure 102
Install spacer

Figure 103
Install 2 bearing locating rings in hub and gear and install into clutch drum. Align splines on hub gear with internal teeth of friction discs. DO NOT FORCE THIS OPERATION. Gear splines must be flush with inner teeth of all inner discs.

Figure 104
Warm outer bearing cone to 120° C [248° F] and install in gear

Figure 105
Warm front taper bearing cone to 120° C [248° F] and install on clutch drum shaft

2nd being disassembled

Figure 106
Remove end plate retaining ring

Figure 107
Remove end plate

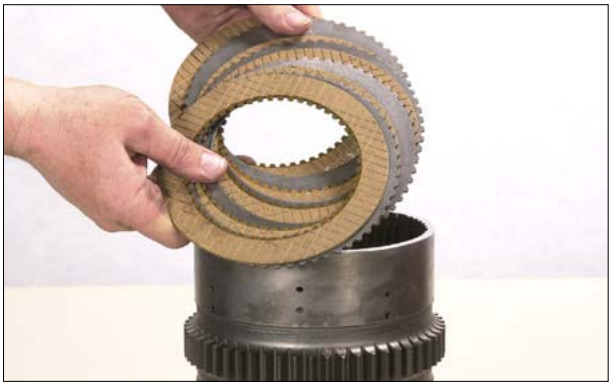

Figure 108
Remove inner and outer discs

Figure 109
Remove spring retaining retainer ring

Figure 110
Remove snap ring retainer

Figure 111
Remove clutch piston return spring discs

Figure 112
Remove clutch piston spacer

Figure 113
Remove clutch piston

Fwd being disassembled

Figure 114
Remove sealing rings (3)

Figure 115
Remove FWD/2nd shaft front bearing retaining ring

Figure 116
Remove FWD:2nd shaft front bearing end plate

Figure 117
Remove FWD/2nd shaft front bearing plate ball

Figure 118
Remove FWD/2nd shaft front bearing outer race

Figure 119
Using a puller remove FWD/2nd shaft front bearing inner race

Figure 120
Remove front bearing retaining snap ring

Figure 121
Using a puller remove gear and hub

Figure 122
Remove end plate retaining ring

Figure 123
Remove end plate

Figure 124
Remove inner and outer discs

Figure 125
Using a puller as shown pull bearing inner race from shaft

Figure 126
Compress return disc springs and remove spring retaining retainer ring

Figure 127
Remove snap ring retainer

Figure 128
Remove clutch piston return spring discs

Figure 129
Remove clutch piston spacer

Figure 130
Remove clutch piston

Fwd being reassembled

Figure 131
Refer to “Cleaning and Inspection “ pages.
Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.

Figure 132
Install spacer

Figure 133
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

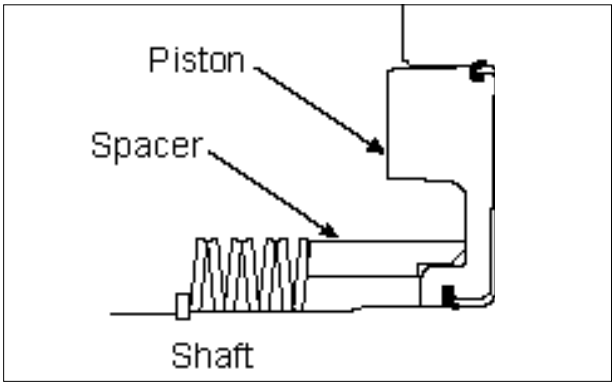

Figure 134
Drawing

Figure 135
Install snap ring retainer ring

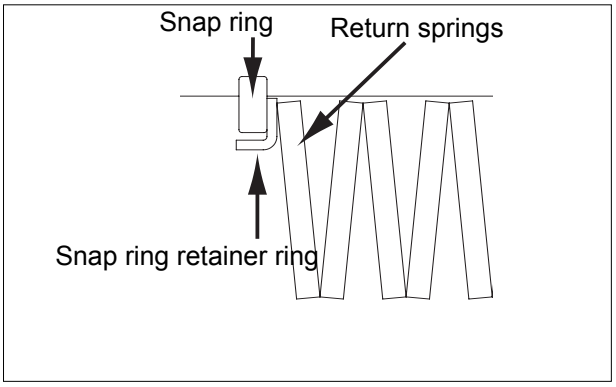

Figure 136
Drawing

Figure 137
Compress spring discs and install spring disc retaining snap ring

Figure 138
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

Figure 139
Install end plate.

Figure 140
Install end plate retaining snap ring

Figure 141
Warm bearing inner race to 120° C [248° F] and install on clutch shaft

Figure 142
Install 2 bearing locating rings in hub and gear and install into clutch drum. Align splines on hub gear with internal teeth of friction discs. DO NOT FORCE THIS OPERATION. Gear splines must be flush with inner teeth of all inner discs.

Figure 143
Warm outer bearing to 120°C [248°F] and install in gear

Figure 144
Install bearing retaining snap ring

Figure 145
Warm bearing inner race to 120°C [248°F] and install on shaft

Figure 146
Install bearing outer race

Figure 147
Install ball

Figure 148
Install spacer

Figure 149
Install retaining snap ring

Figure 150
Install sealing rings (3)

2nd being reassembled

Figure 151
Refer to “Cleaning and Inspection “ pages.
Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.

Figure 152
Install spacer

Figure 153
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

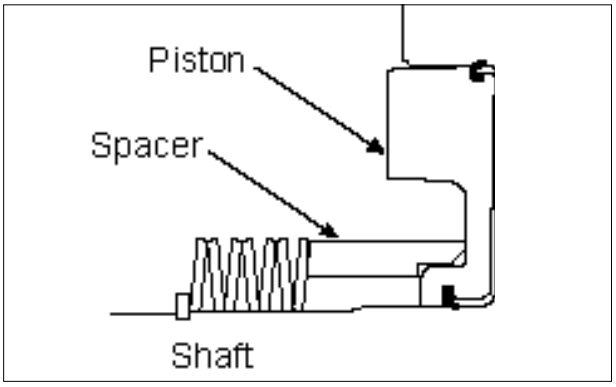

Figure 154
Drawing

Figure 155
Install snap ring retainer

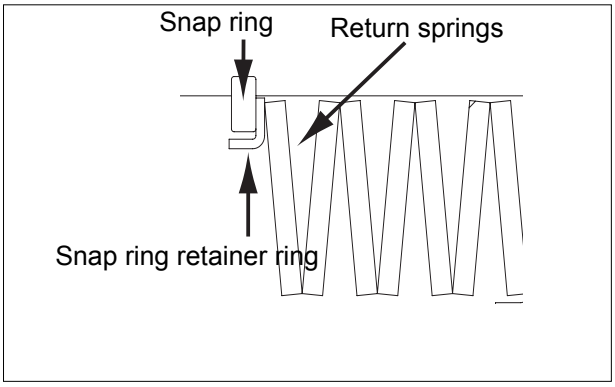

Figure 156
Drawing

Figure 157
Install snap ring

Figure 158
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

Figure 159
Install end plate.

Figure 160
Install end plate retaining snap ring

Figure 161
Remove sealing rings (2)

Figure 162
Remove front bearing retaining ring

Figure 163
Using a puller remove front bearing from shaft

Figure 164
Remove end plate retaining ring

Figure 165
Remove end plate

Figure 166
Remove inner and outer clutch discs

Figure 167
Remove spring retainer snap ring

Figure 168
Remove spring discs

Figure 169
Remove spacer

Figure 170
Remove piston

Figure 171
Refer to “Cleaning and Inspection “ pages.
Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.

Figure 173
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

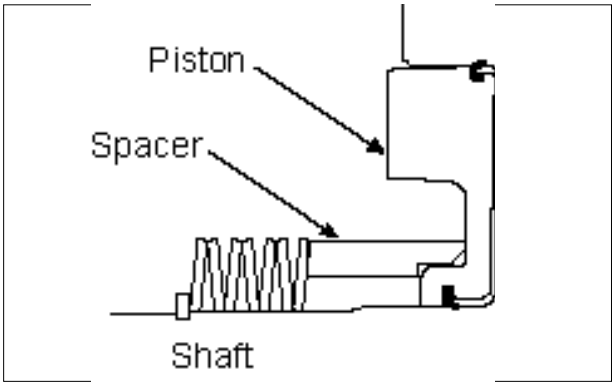

Figure 174
Drawing

Figure 172
Install spacer

Figure 175
Install snap ring

Figure 176
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

Figure 177
Install end plate.

Figure 178
Install end plate retaining snap ring

Figure 179
Turn shaft and warm bearing to 120°C [248°F] and install bearing

Figure 180
Install bearing retaining snap ring

Figure 181
Install sealing rings (2)

Rev being disassembled

Figure 182
Remove sealing rings (3)

Figure 183
Remove front bearing retaining snap ring

Figure 184
Remove front bearing end plate

Figure 185
Remove front bearing end plate lock ball

Figure 186
Remove front bearing outer race

Figure 187
Using a puller remove front bearing inner race

Figure 188
Remove bearing retaining snap ring

Figure 189
Using a puller remove gear and hub and outer bearing as an assy

Figure 190
Using a puller remove inner bearing

Figure 191
Remove end plate retaining snap ring

Figure 192
Remove end plate

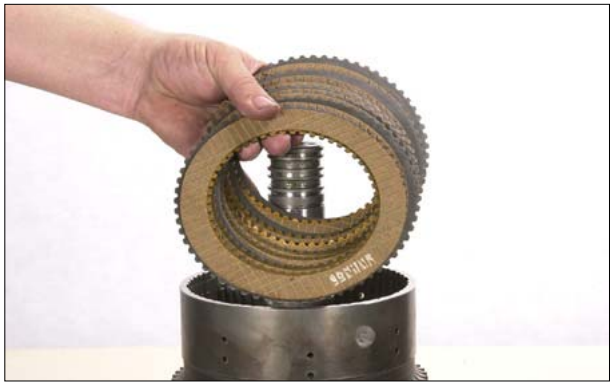

Figure 193
Remove inner and outer discs

Figure 194
Compress return spring discs and remove snap ring

Figure 197
Remove spacer

Figure 195
Remove spring retainer

Figure 198
Remove piston

Figure 196
Remove spring discs

3rd being disassembled

Figure 199
Using a puller remove rear bearing

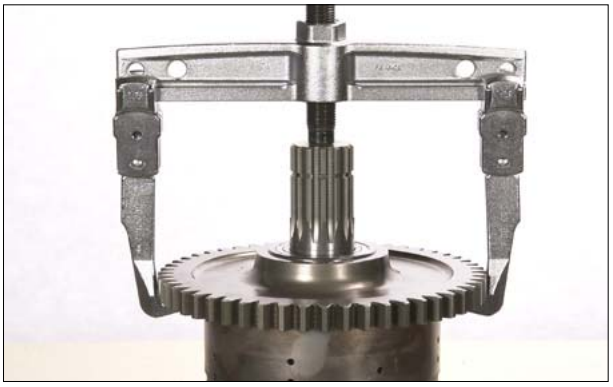

Figure 200
Using a puller remove gear and hub and outer bearing

Figure 201
Remove bearing spacer

Figure 202
Using a puller remove inner bearing

Figure 203
Remove end plate retaining ring

Figure 204
Remove end plate

Figure 205
Remove inner and outer discs

Figure 206
Compress return spring discs and remove retaining snap ring

Figure 207
Remove snap ring retainer

Figure 208
Remove spring discs

Figure 209
Remove spacer

Figure 210
Remove piston

Rev being reassembled

Figure 211
Refer to “Cleaning and Inspection “ pages.
Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.

Figure 212
Install spacer

Figure 213
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

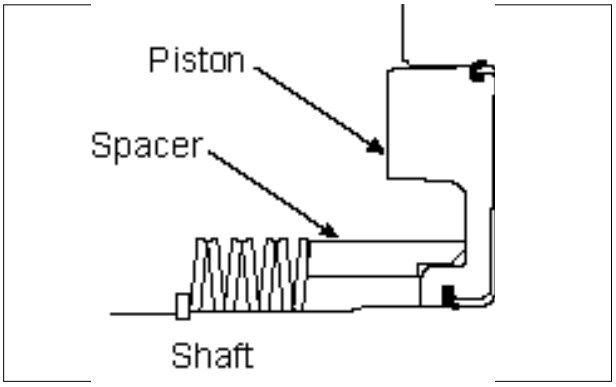

Figure 214
Drawing

Figure 215
Install snap ring retainer

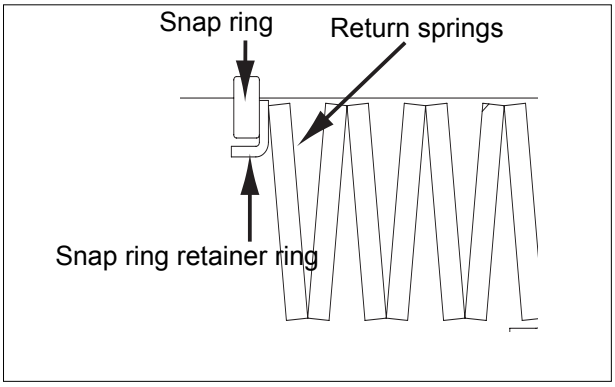

Figure 216
Drawing

Figure 217
Install snap ring

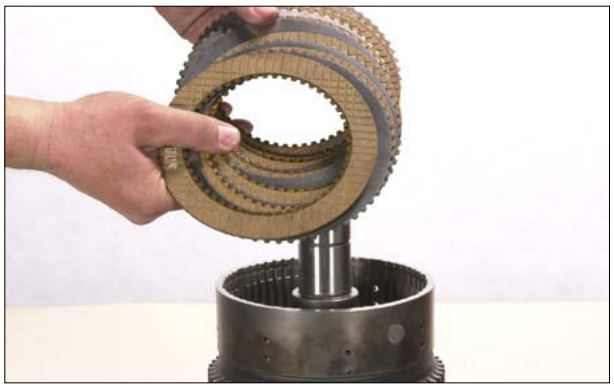

Figure 218
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

Figure 219
Install end plate.

Figure 220
Install end plate retaining snap ring

Figure 221
Warm inner bearing to 120°C [248°F] and install bearing

Figure 222 Check if 2 bearing locating rings are in gear/hub and install gear/hub

Figure 223
Warm outer bearing to 120°C [248°F] and install bearing in gear/hub

Figure 224
Install retaining ring

Figure 225
Warm bearing inner race to 120°C [248°F] and install inner race

Figure 226
Install bearing outer race

Figure 227
Install front bearing end plate lock ball

Figure 228
Install front bearing end plate

Figure 229
Install end plate retaining snap ring

Figure 230
Install sealing rings (3)

3rd being reassembled

Figure 231
Refer to “Cleaning and Inspection “ pages.
Install piston inner and outer seal.
Note: Seals must be sized prior to installation in clutch drum. Sizing is best accomplished by rotating the clutch piston whilst holding a round object against the new sealing ring. Rotate piston until seal ring is flush with outer diameter of the piston.

Figure 232
Install spacer

Figure 233
Install piston return spring discs. First spring disc with large diameter of bevel towards spacer.

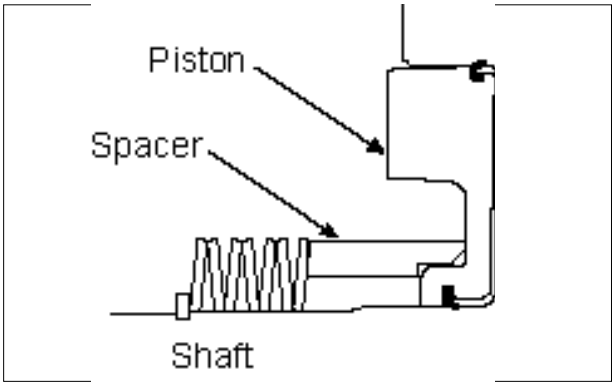

Figure 234
Drawing

Figure 235
Install snap ring retainer

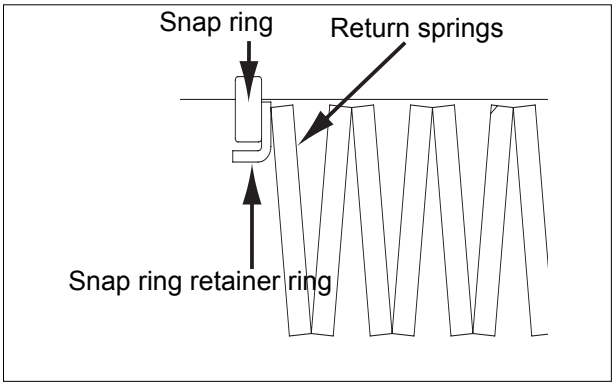

Figure 236
Drawing

Figure 237
Install snap ring

Figure 238
Install inner and outer discs. First disc is steel. Alternate friction and steel discs until proper amount are installed. Last disc is friction disc.

Figure 239
Install end plate.

Figure 240
Install end plate retaining snap ring

Figure 241
Warm inner bearing to 120°C [248°F] and install inner bearing

Figure 242
Install spacer

Figure 243
Check if 2 internal bearing locating rings are in place and install gear and hub

Figure 244
Warm outer bearing to 120°C [248°F] and install outer bearing

Figure 245
Warm clutch shaft bearing to 120°C [248°C] and install bearing on shaft

Figure 246
Using a puller remove bearing

Figure 247
Using a puller remove bearing inner cone

Figure 248
Turn shaft and using a puller remove bearing

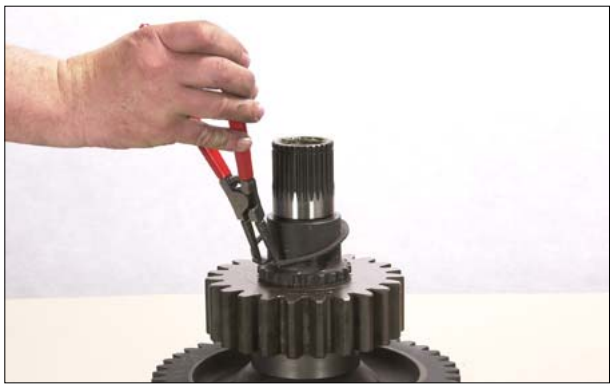

Figure 249
Remove snap ring

Figure 250
Remove idler shaft gear

Figure 251
Remove spacer

Figure 252
Install spacer

Figure 253
Install idler shaft gear

Figure 254
Install snap ring

Figure 255
Warm bearing to 120°C [248°F] and install bearing on shaft

Figure 256
Turn shaft and warm bearing assy to 120°C [248°F] and install on shaft

Output shaft being disassembled

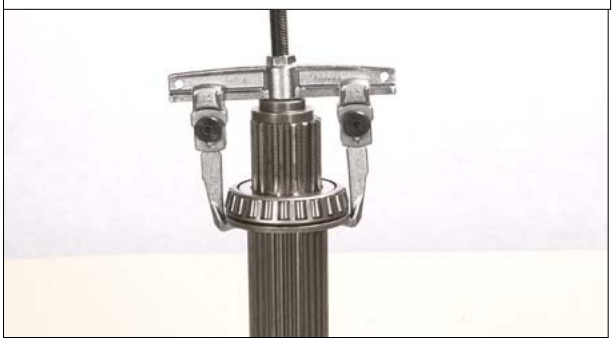

Figure 257
Using a puller remove bearing

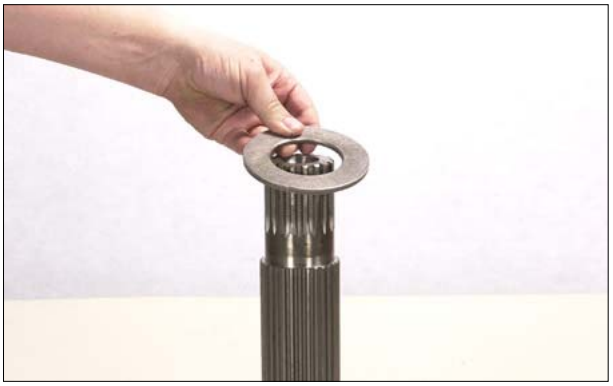

Figure 258
Remove thrust washer

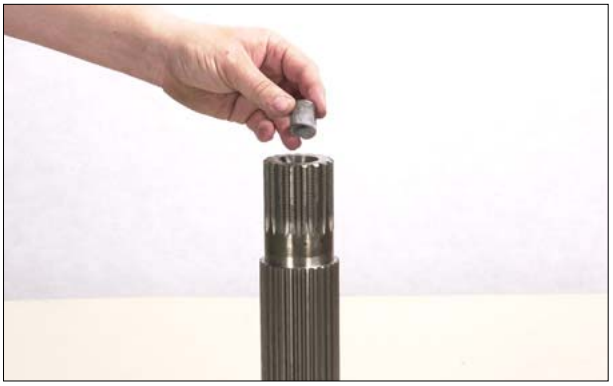

Figure 259
Remove output shaft bushing

Output shaft being reassembled

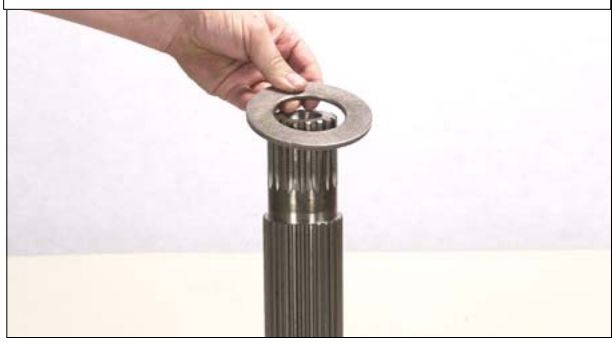

Figure 260
Install thrust washer

Figure 261
Warm bearing to 120°C [248°F] and install on shaft

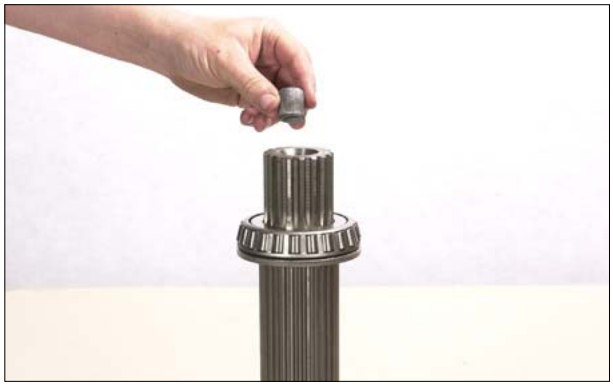

Figure 262
Install output shaft bushing

Disassembly

Figure 263
Remove plug

Figure 264
Remove shaft, spring and ball

Reassembly

Figure 265
Install spring, ball and shaft

Figure 266
Install plug

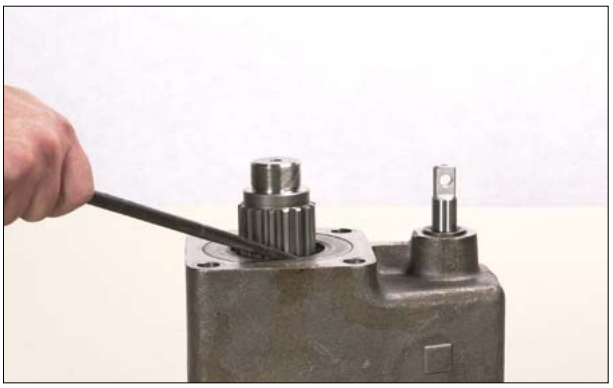

Figure 267
Remove oil seal

Figure 268
Remove snap ring

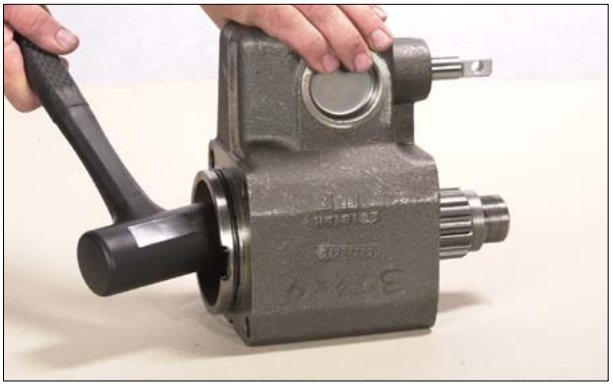

Figure 269
Gently tap shaft from disconnect housing

Figure 270
Remove plug

Figure 271
Remove shift fork lock screw

Figure 272
Remove shaft, spring and ball

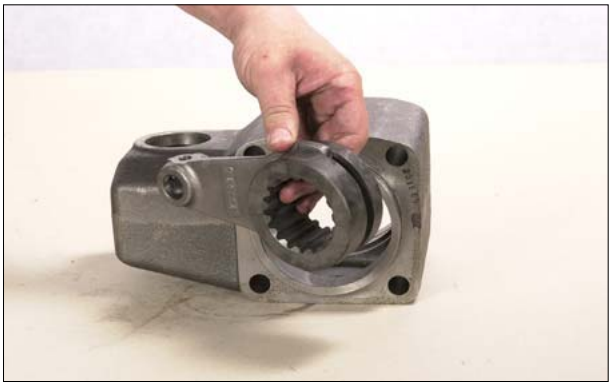

Figure 273
Remove shift hub and disconnect fork

Figure 274
Remove oil seal

Figure 275
Using a puller remove bearing from shaft

Figure 276
Using a puller remove bearing from shaft

Figure 277
Install oil seal

Figure 280
Install plug use a small amount of Loctite

Figure 278
Install Spring, ball and shaft

Figure 281
Install shaft in disconnect housing

Figure 279
Install shift fork lock screw use a small amount of Loctite

Figure 282
Install retaining ring

Figure 283
Install oil seal

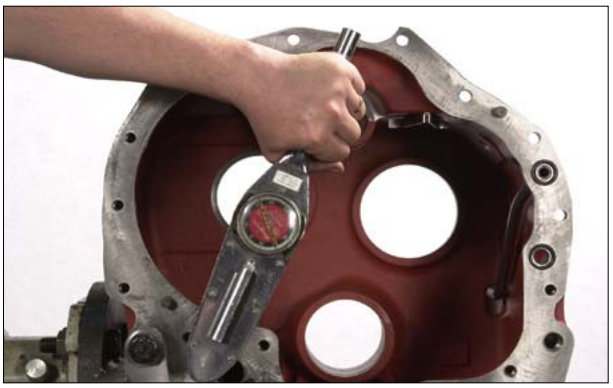

Figure 284
Install o-ring, suction tube and torque screws as required

Figure 285
Install oil baffle

Figure 286
Install low range gear

Figure 287
Install shift hub

Figure 288
Install sleeve

Figure 289
Install high range gear

Figure 290
Install front caged roller assy

Figure 291
Install output shaft assy

Figure 292
Install output shaft front bearing outer race

Figure 293
Install new o-ring on front disconnect housing and shims (see procedure)

Figure 294
Install front disconnect capscrews and torque as required

Figure 295
Install rear caged roller assy

Figure 296
Install thrust washer

Figure 297
Install output shaft rear bearing inner race.

Figure 298
Install rear output shaft cap

Figure 299
Install rear output shaft cap capscrews and torque as specified

Figure 300
Measure output shaft rolling torque (procedure)

Figure 301
Install shift fork

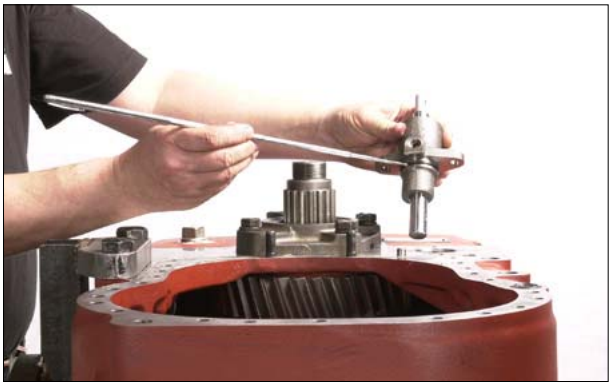

Figure 302
Install shift rail assy

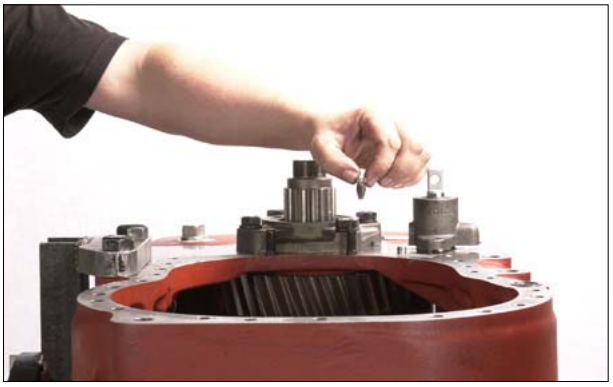

Figure 303
Apply a thin coat of Loctite and install lock screw and torque

Figure 304
Install capscrews and torque

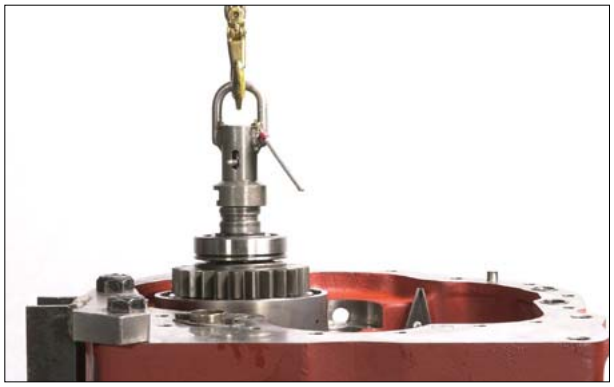

Figure 305
Install REV/3rd clutch drum assy

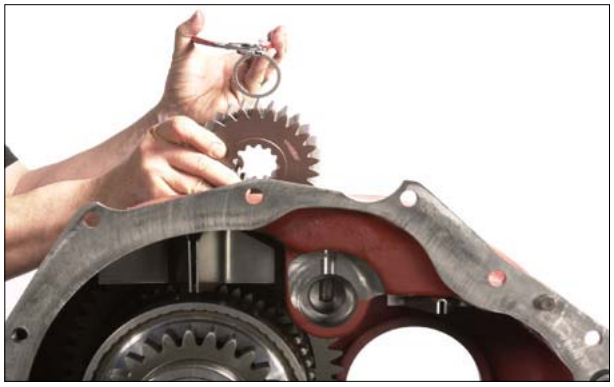

Figure 306
From the rear install hub and secure with snap ring

Figure 307
Install low front bearing cup into transmission case

Figure 308
Install low clutch assy into transmission case

Figure 311
Install low shaft speed sensor gear

Figure 309
Install idler shaft

Figure 312
Install low shaft speed sensor gear screws and torque to specified torque

Figure 310
Warm low shaft rear bearing cone to 120°C [248°F] and install

Figure 313
Install low shaft sealing ring

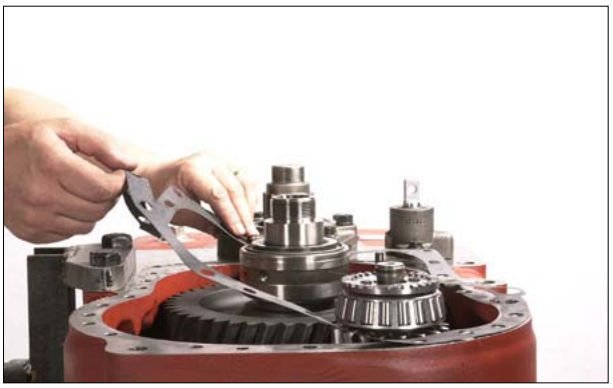

Figure 314
Install transmission cover rear gasket

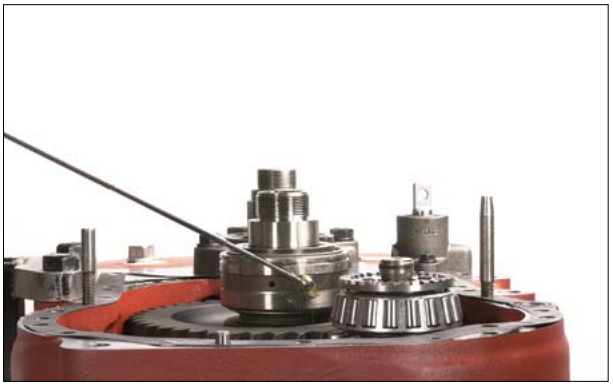

Figure 315
Use a small amount of grease to install idler shaft locating ball

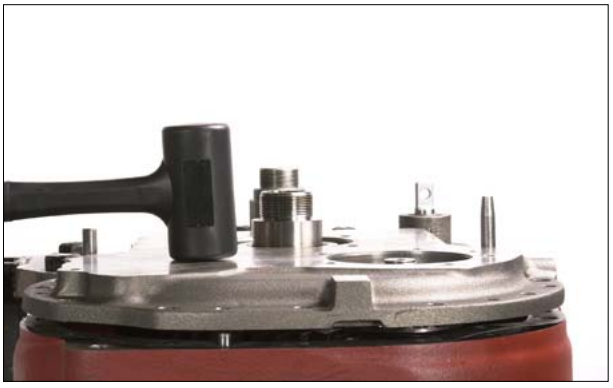

Figure 316
Install two aligning studs and gently tap rear cover into place

Figure 317
Remove aligning studs, install screws and torque as specified

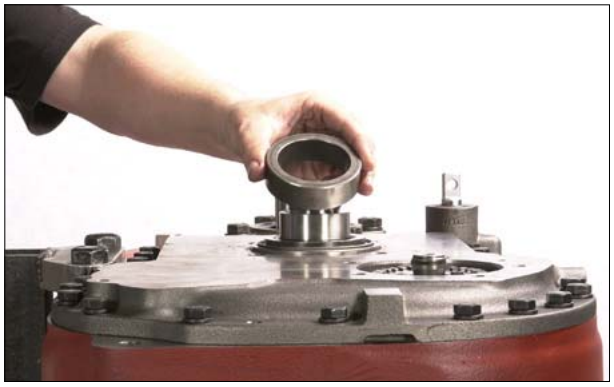

Figure 318
Install idler shaft spacer

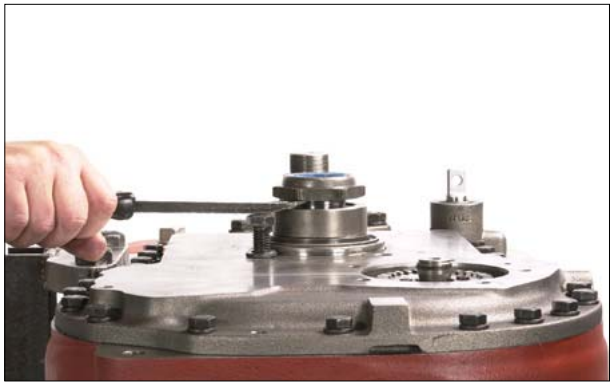

Figure 319
Install 1 screw and shaft nut as shown and lift idler shaft

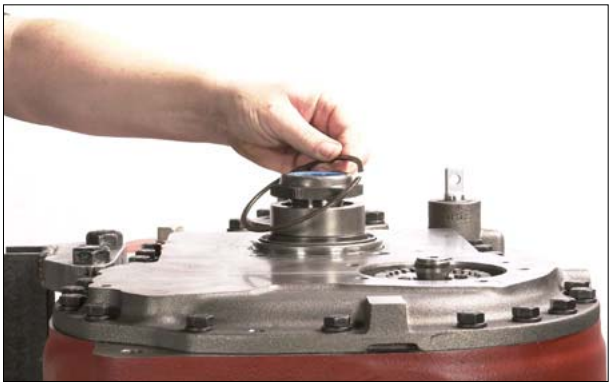

Figure 320
Install shaft rear locating snap ring

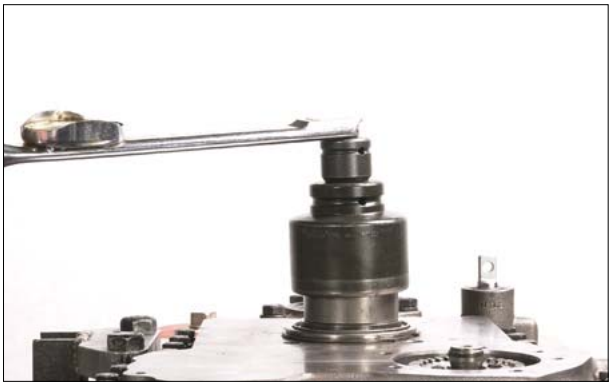

Figure 321
Torque idler shaft nut to specified torque

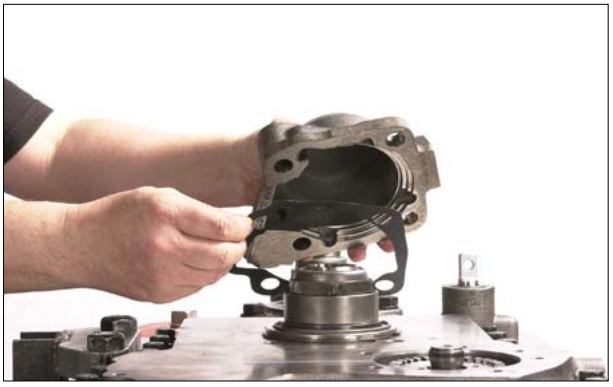

Figure 322
Install idler shaft gasket and bearing cap

Figure 323
Install screws and torque as specified

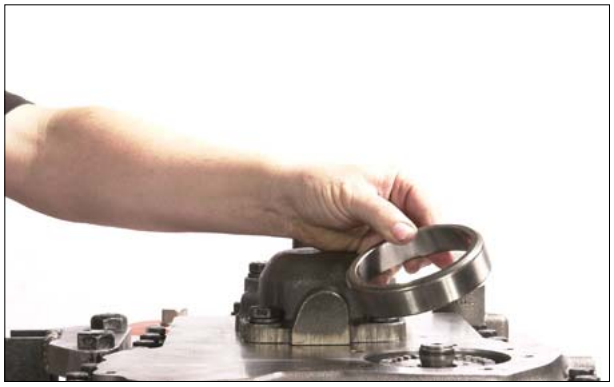

Figure 324
Install low shaft rear bearing outer race

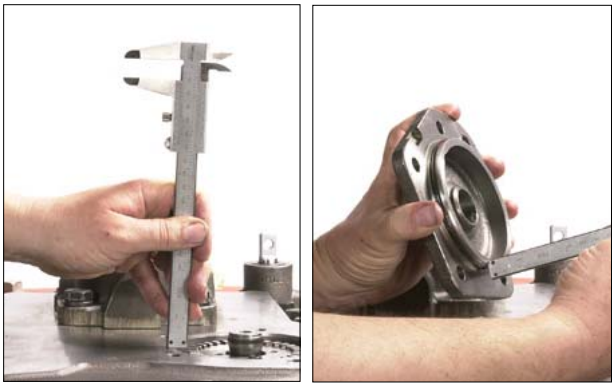

Figure 325
See shim procedure for proper shimming of low shaft rear bearing cap

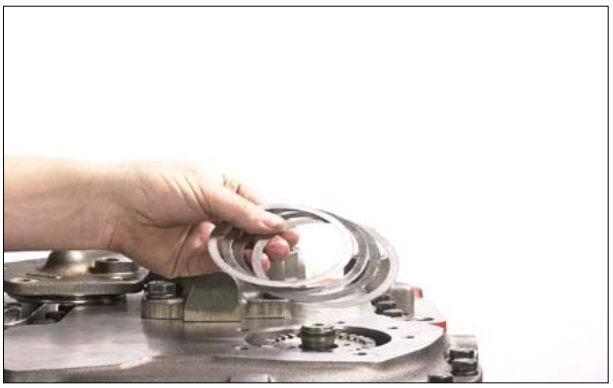

Figure 326
Add shims as required

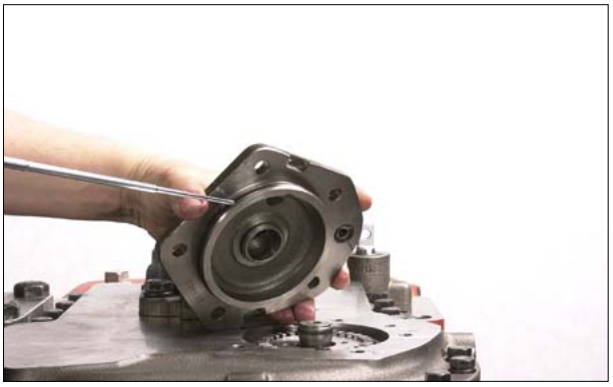

Figure 327
Install new o-ring on low shaft bearing cap and install cap

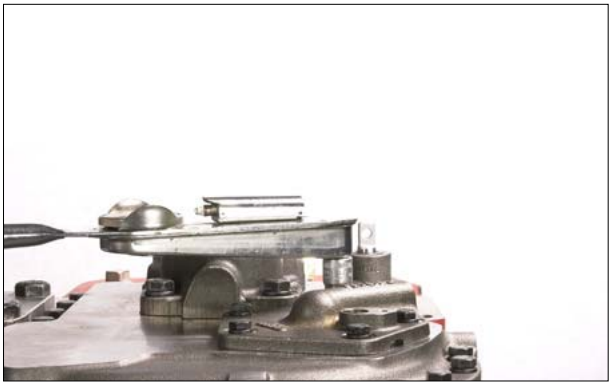

Figure 328
Install screws and torque as specified

Figure 329
Install speed sensors (3) and screws. Torque to specified torque

Figure 330
Install rear output flange, o-ring, washer and nut

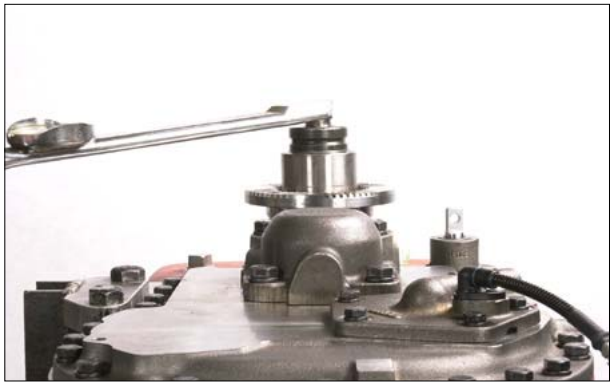

Figure 331
Torque rear output flange nut to specified torque

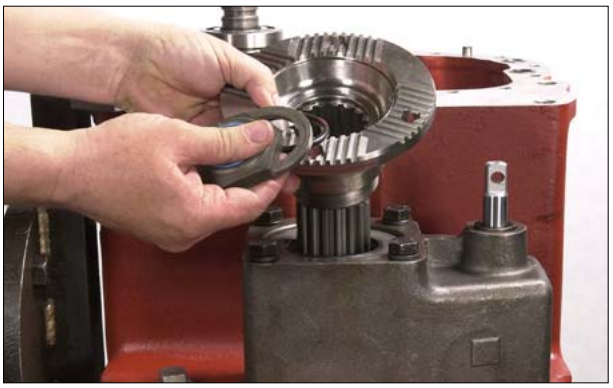

Figure 332
Install front output flange, o-ring, washer and nut

Figure 333
Torque front output flange nut to specified torque

Figure 334
Install 2nd clutch hub

Figure 335
Install 2nd clutch hub retaining ring

Figure 336
Install spacer

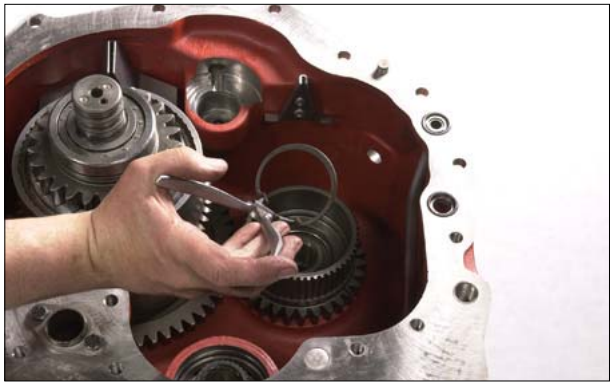

Figure 337
Install snap ring

Figure 338
Install 4th clutch hub

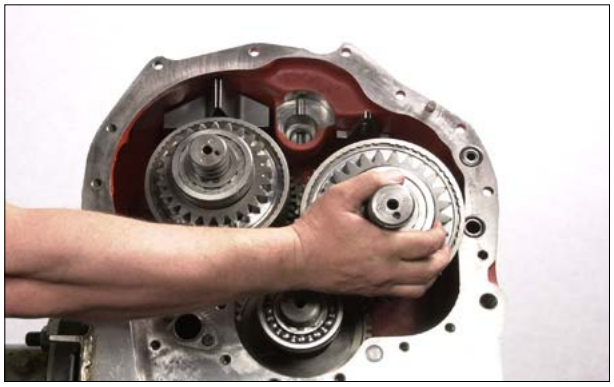

Figure 341
Install 2nd clutch assy into transmission case

Figure 339
Install snap ring

Figure 342
Install 2 aligning studs and using a light coat of grease place gasket

Figure 340
Install 4th clutch assy into transmission case

Figure 343
Install input shaft assy in front cover

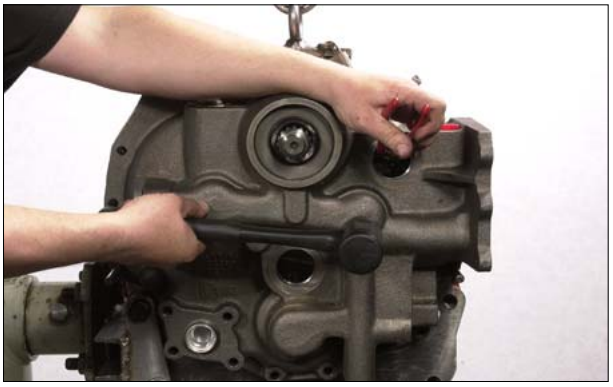

Figure 344
Using spreading pliers spread ears of fwd front bearing retaining ring and lightly tap on cover

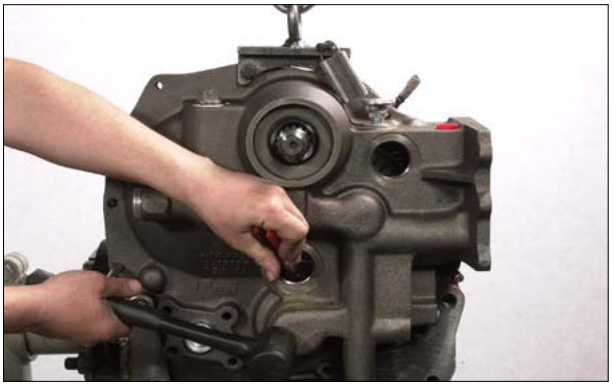

Figure 345
Using spreading pliers spread ears of 4th front bearing retaining ring and tap cover into place

Figure 346
Place screws and torque as specified

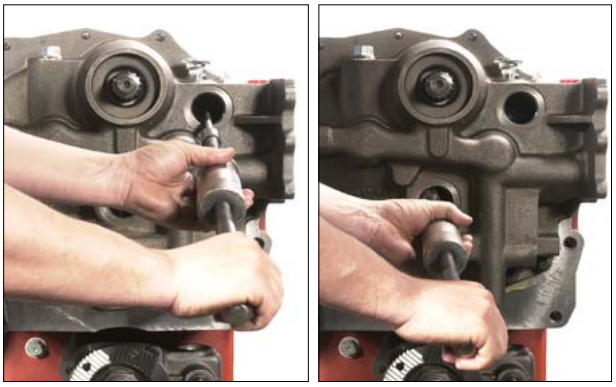

Figure 347
Using a sliding hammer pull 2nd and 4th clutch forward until retaining ring snaps into place

Figure 348
Install plugs (2) and torque as specified

Figure 349
Install front input flange, o-ring ,washer and nut and torque as specified

Figure 350
Install 2 aligning studs and install control valve plate gasket

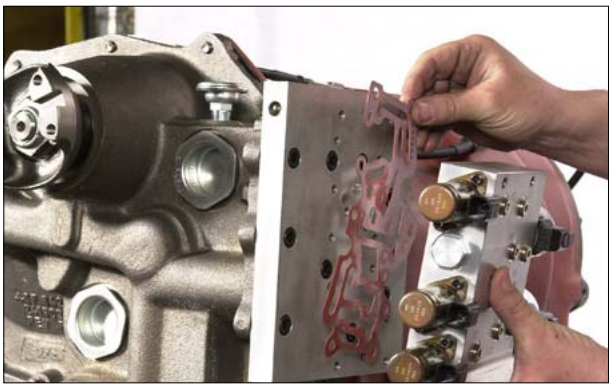

Figure 353
Install control valve gasket and control valve

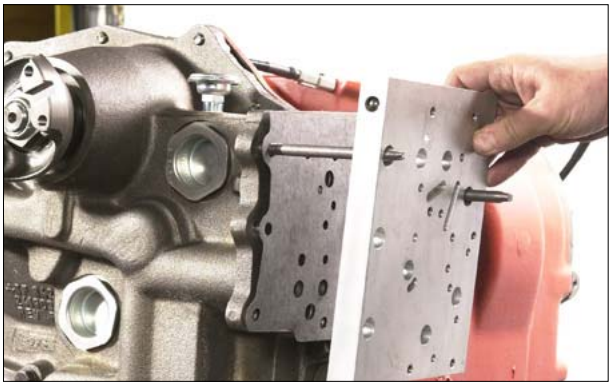

Figure 351
Install control valve plate

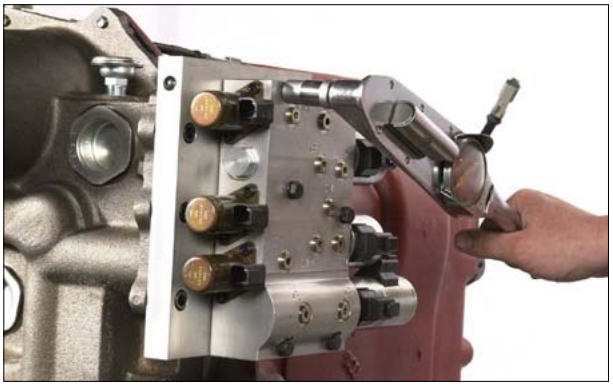

Figure 354
Install screws and torque as specified

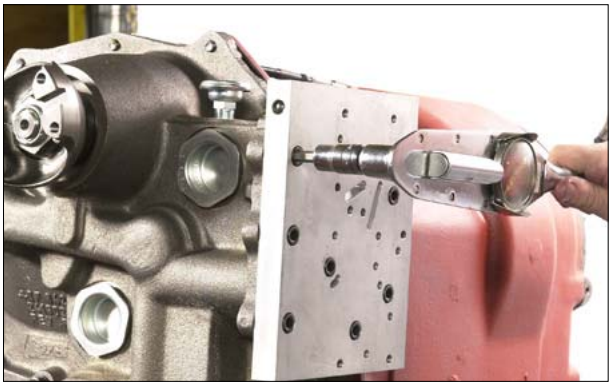

Figure 352
Install screws and torque as specified

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